The Engineer

UNIVERSITY OF MICHIGAN
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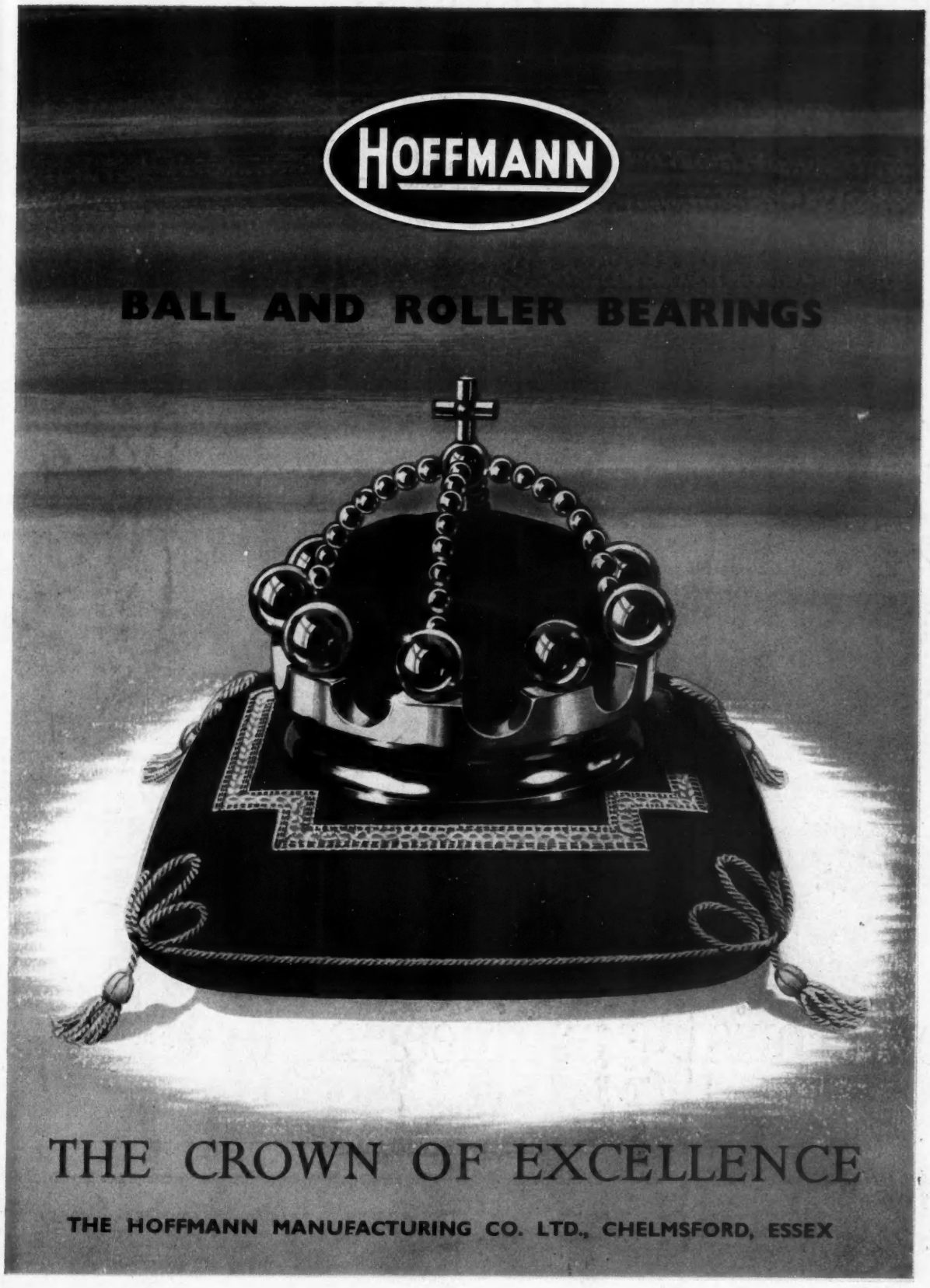

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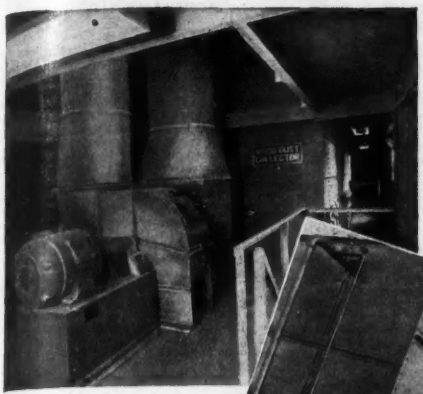
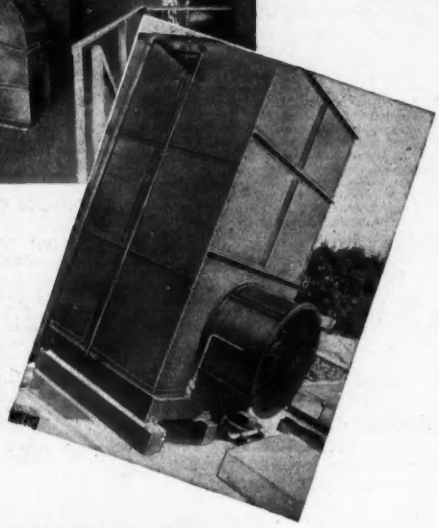


No. 545 "Visco-Beth" Automatic Dust Collector (showing collector mechanism and main suction fan) installed in a Lancashire Lime Works.



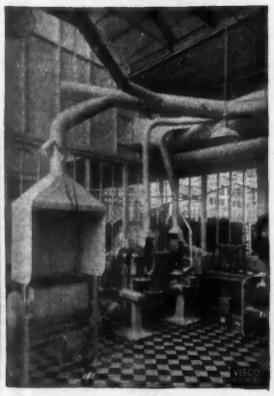
No. 578 "Visco" Steel Shell Water Cooler, capacity 5,500 g.p.h. used in conjunction with an Air Conditioning Plant at a factory in the Midlands.

VISCO *for*

AIR-CONDITIONING DUST COLLECTING & WATER COOLING PLANT

Although the name "Visco" is so well known in many branches of industry, many people are unaware of the wide range of our activities. Some know us as makers of Air Filters, others as builders of Water Cooling Towers or manufacturers of Dust Collecting Plant. In fact, we design, manufacture and install:—Air Filters of all sizes—static, and self-cleaning types; Water Coolers in steel, timber or ferro-concrete; Oil Coolers, Dust Collectors for every purpose—cyclones, unit dust collectors, and "Visco-Beth" automatic collectors of remarkable efficiency. Industrial Ventilating and Air Conditioning is also an important part of our business, and we can undertake a complete installation, or supply separate components.

No. 547 "Visco" Heating and Ventilating plant supplied to Messrs. May & Baker Ltd. Photo shows view of dust remover hoods on powder mixer and tabletting machines.



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Our technical staff is at your service, and your enquiries will be welcomed.

VISCO
ENGINEERING Co LTD
STAFFORD ROAD. CROYDON.

Phones: Croydon 4181/4
Grams: CURTMIT, Croydon

THE ENGINEER

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PRINCIPAL CONTENTS

(Complete contents on page 112)

Atomic Energy and Possible Developments ... 112

Some Problems in Flexural Testing 98
(F. A. BLAKEY)

The "Intrinsic Efficiency" of a Flow Type Air Compressor 101
(B. DOWNS)

Performance and Efficiency Tests on the "Britannia" Locomotives—No. I 103
(O. S. NOCK)

The Staythorpe-West Melton Section of the 275kV Grid—No. II 116

Machining Plant for Turbine Casings 105

Diesel-Electric Locomotives for Australia 108

The Function of the Large Carrier 112

NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

SUBSCRIPTIONS

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WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

INDEX TO ADVERTISERS—PAGE 131

PUBLIC APPOINTMENTS

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

BRITISH RUBBER PRODUCERS' RESEARCH FELLOWSHIP

Applications are invited for the BRITISH RUBBER PRODUCERS' RESEARCH FELLOWSHIP, value up to £500 per annum. The Fellowship has been instituted to encourage research into the mechanical properties of rubber. Applicants should have a good Honours Degree in Engineering or Physics and industrial or research experience.

Full particulars and application form may be obtained from the Registrar, University of Nottingham, to whom applications should be submitted as soon as possible. E9554

WOOLWICH POLYTECHNIC, LONDON, S.E.18.

Principal: J. S. TAIT, Ph.D., B.Sc., A.R.T.C., M.I.E.E., A.M.I.Mech.E.

ELECTRICAL ENGINEERING DEPARTMENT

ASSISTANT, GRADE A

Applications invited for an ASSISTANT, Grade A, in the Electrical Engineering Department from candidates with an Engineering Degree in Electrical Subjects. Facilities for research. Post suitable for a person recently graduated; industrial experience an advantage.

Salary, Burnham Technical Scale (Further Education) between £511 and £832, according to qualifications and experience.

Particulars and application form from Clerk to Governors to be returned by 15th August, 1953. E9545

COUNTY BOROUGH OF ROTHERHAM

EDUCATION COMMITTEE

ROTHERHAM TECHNICAL COLLEGE

Principal: Mr. G. E. COOKE, M.A.

ASSISTANT LECTURER

Applications are invited for appointment as ASSISTANT LECTURER in the Department of Mechanical Engineering, to commence duties on 1st September, 1953, or as soon as possible thereafter.

The work of the Department includes Final Examinations for City and Guilds, Higher National Certificates in Mechanical Engineering and Production Engineering, and External Degrees of London University in Mechanical Engineering. Facilities are available for research.

Candidates should possess a Degree or equivalent qualification and should preferably have had industrial experience.

Salary in accordance with the Burnham (Technical) Scales, 1951, Grade A (£415–£670 per annum), or Grade B (£490–£765 per annum), according to qualifications and experience.

Application forms may be obtained from the undersigned, to whom they should be returned within a fortnight of the appearance of this advertisement.

R. BLOOMER,
Director of Education.

Education Offices,
Rotherham. E9536

ROYAL NAVAL COLLEGE, GREENWICH, LONDON, S.E.10.

DEPARTMENT OF APPLIED MECHANICS

CIVILIAN LECTURER

Applications are invited for appointment as CIVILIAN LECTURER in the Department of Applied Mechanics, in September, 1953, or as soon after as possible. Candidates must be British subjects, 28 years of age or over, and should possess a First or Second Class Honours Degree in Mechanical Engineering. Preference will be given to candidates with a knowledge of one or more of the following subjects: (i) materials and structures; (ii) fluid mechanics, including supersonics; (iii) ballistics; (iv) servo-mechanisms.

Appointment will be as Senior Lecturer (salary approximately £810 to £1020). In certain circumstances a starting salary above the minimum may be authorised. Consideration would be given to the secondment for an agreed period of serving members of the Scientific Civil Service. Letters of application, accompanied by names of three referees and a statement of previous experience, to be sent as soon as possible to Director of Studies, Royal Naval College, Greenwich, S.E.10, from whom further particulars may be obtained. Closing date for applications is 8th August, 1953. E9615

NORTHAMPTON POLYTECHNIC, ST. JOHN STREET, LONDON, E.C.1.

ASSISTANT LECTURER, GRADE A

ASSISTANT LECTURER Grade A, to teach a selection of mechanical engineering subjects in Degree and National Certificate courses.

Salary scale: Assistant Grade A (Graduate or equivalent) £511 by £18 to £778, and usual allowances.

Further particulars and forms of application obtainable from the Secretary.

J. E. RICHARDSON,
E9605 Ph.D., B.Eng., M.I.E.E., Principal.

PUBLIC APPOINTMENTS

MIDDLESEX COUNTY COUNCIL

EDUCATION COMMITTEE

ACTON TECHNICAL COLLEGE
HIGH STREET, ACTON, W.3.

MECHANICAL ENGINEERING DEPARTMENT

LECTURER AND ASSISTANTS GRADE B

Applications are invited for:

(a) LECTURER.—Candidates should hold an Engineering Degree or equivalent, have had suitable industrial and teaching experience, and be capable of taking classes at the level of Higher National Certificate and Final B.Sc. (Engineering).

(b) ASSISTANT, Grade B.—Candidates should hold a Degree in Engineering or its equivalent, have industrial and teaching experience and be capable of taking classes to Higher National Certificate standard.

(c) ASSISTANT, Grade B.—Candidates should have sound industrial experience and a good knowledge of machine shop work. Preference will be given to those holding Higher National Certificate and who have had some teaching experience.

Salary (per annum)

	Men	Women
Lecturer ...	£940×£25–£1040	£752×£20–£832
Grade B ...	£490×£25–£765	£437×£20–£536

Plus London allowance (£36 or £48) and other allowances where applicable.

Forms of application may be obtained from the Principal, to whom completed forms should be returned as soon as possible.

C. E. GURR,
Chief Education Officer and Secretary
E9601 to the Education Committee.

MINISTRY OF FUEL AND POWER

MINES INSPECTORATE

The Civil Service Commissioners invite applications from men for the following permanent posts:—

(a) 6 INSPECTORS OF MINES AND QUARRIES (Provinces).

(b) 1 INSPECTOR OF MECHANICAL ENGINEERING IN MINES AND QUARRIES (London).

Age at least 27 on 1st May, 1953.

Post (a).—Candidates must have a First Class Certificate of Competency under the Coal Mines Act, 1911, and have held a responsible position at a mine, preferably a coal mine. A varied experience desirable and practical knowledge and experience of metalliferous mining and quarrying will be an advantage.

Post (b).—University Degree in Mechanical Engineering (or equivalent qualifications) and practical experience in mechanical engineering essential.

Inclusive salary (London), £917 (at age 30) to £1151 (somewhat lower in provinces). Starting pay according to age, e.g., £823 at 27, £980 at 32 or over on entry. Higher starting salary may be granted for exceptional qualifications. Promotion prospects.

Further particulars and application forms from Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4227/53. Application forms must be returned by 27th August, 1953. E9604

SUPERINTENDENT, HOSPITAL LIMB AND INSTRUMENT WORKSHOP

SINGAPORE GOVERNMENT

MEDICAL DEPARTMENT

SUPERINTENDENT, Hospital Limb and Instrument Workshop, required by Singapore Government, Medical Department, for tour of 3 years, with prospect of pensionable employment. Salary &c., according to experience, in scale equivalent to £1134, rising to £1673 a year for single man. Additional allowances up to £532 a year payable to married men, according to salary and dependants. Free passages. Liberal leave on full salary. Candidates should hold a recognised diploma or certificate of proficiency in workshop and bench procedure and should have special knowledge of making orthopædic appliances. They should also have a knowledge of woodwork, leatherwork, metalwork (including welding), recent plastics and their uses in orthopædic surgery and making artificial limbs.

Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3B/33675/EH. E9606

LINCOLNSHIRE RIVER BOARD

SEA DEFENCE WORKS

APPOINTMENT OF ENGINEERS

Applications are invited for the appointment of SENIOR and JUNIOR ENGINEERS in connection with the restoration of the sea defences in the River Board area. It is anticipated that the appointments will be for a minimum period of two years.

(a) Senior.—Grade A.P.T. VII.

(b) Junior.—Grade A.P.T. III if successful applicants have passed Part A of the Associate Membership examination of the Institution of Civil Engineers, otherwise Grade A.P.T. I.

Appointments will be subject to the provisions of the Local Government Superannuation Act, 1937, and to the passing of a medical examination.

Applications, giving age, qualifications, full details of training, present position and salary, together with the names of two referees, should be submitted to the undersigned not later than the 27th July, 1953.

G. E. PHILLIPPO,
Clerk of the Board.

50, Wide Bargate,
Boston, Lincs. E9511

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

PATENT EXAMINER AND PATENT OFFICER CLASSES

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS

The Civil Service Commissioners invite applications for permanent and pensionable appointments to be filled by competitive interview during 1953. Interviews will continue throughout the year, but a closing date for the receipt of applications earlier than December, 1953, may eventually be announced. The scientific posts are in various Government Departments and cover a wide range of scientific research and development in most of the major fields of fundamental and applied science; in biology the number of vacancies is small. The patent posts are in the Patent Office (Board of Trade), Admiralty and Ministry of Supply.

Candidates must have obtained a University Degree with First or Second Class Honours in an appropriate scientific subject (including engineering) or in mathematics, or an equivalent qualification; or for scientific posts possess high professional attainments. Candidates for Senior Scientific Officer posts must, in addition, have had at least three years' post-graduate or other approved experience. Candidates for Scientific Officer and patent posts taking their degrees in 1953 may be admitted to compete before the result of their degree examination is known.

Age limits: Senior Scientific Officers, between 26 and 31; for Scientific Officers and Patent Classes, between 21 and 28 during 1953 (up to 31 for permanent members of the Experimental Officer class competing as Scientific Officers). London salary scales: Senior Scientific Officers (men), £812-£1022; (women), £681-£917; Scientific Officers (men), £440-£707; (women), £440-£576; Patent Examiner and Patent Officer classes (men), £440-£655; (women), £440-£576. Somewhat lower rates in the provinces.

Further particulars from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.53/53 for Senior Scientific Officers and S.52/53/S.128/53 for the other posts. E9579

METROPOLITAN WATER BOARD

APPOINTMENT OF ASSISTANT ENGINEER (MECHANICAL)

Applications are invited for appointment as ASSISTANT ENGINEER (MECHANICAL) on the permanent pensionable staff. Salary scale £719–£886 per annum. Commencing salary according to age, qualifications and experience. Maximum age 45 years. It is a condition of the appointment to and the continued holding of this position that the selected candidate shall be and continue to be a subscribing member of the Institution of Mechanical Engineers.

Responsible experience in the layout, specification, design and installation of all types of water pumping plant is necessary.

Housing accommodation may be available.

Particulars and a form of application may be obtained from the undersigned on receipt of a stamped, addressed, foolscap envelope quoting reference (G.1), and completed applications must arrive not later than 12th August, 1953.

W. S. CHEVALIER,
Clerk of the Board.

Offices of the Board: New River Head, Rosebery Avenue, London, E.C.1. E9379

MINISTRY OF SUPPLY

DESIGN ESTABLISHMENT

ELECTRICAL OR MECHANICAL ENGINEER

ELECTRICAL or MECHANICAL ENGINEER required by Ministry of Supply, Design Establishment, near Sevenoaks, Kent, to lead section engaged in design and development of electrical and mechanical components and of complete control schemes for armament equipments. Qualifications: First or Second Class Honours Degree or equivalent in Elec. or Mech. Eng., and at least three years' post-graduate research experience. Some practical knowledge of electronics desirable and experience of one or more of the following required:—Electrical machines and control gear design, servo mechanisms, hydraulics and I.C. engines. Salary within range: Senior Scientific Officer (min. age 26), £781–£980; women somewhat less. Post unestablished. F.S.S.U. benefits may be available.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D285/53A E9572

MINISTRY OF WORKS

STRUCTURAL ENGINEERING DRAUGHTSMEN

STRUCTURAL ENGINEERING DRAUGHTSMEN required in London, at Risley (Warrington), Harwell (near Didcot, Berks), and other provincial centres. Accommodation available for single men at Risley and Harwell.

London salary up to £628 per annum. Starting pay according to age, qualifications and experience. Rates outside London are slightly lower.

Applicants should be experienced in design and/or detailing of either reinforced concrete or structural steelwork. The work is varied and not confined to standard schemes. Reasonable prospects of promotion. Although these are not established posts, many have long-term possibilities and competitions are held periodically to fill established vacancies.

Write, stating age, nationality, experience and locality preferred, to Chief Structural Engineer, W.G.10/S.2, Ministry of Works, Abell House, John Islip Street, London, S.W.1. E8832

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

MECHANICAL AND ELECTRICAL ENGINEERING BRANCH

ASSISTANT ENGINEER

National Coal Board invite applications for the superannuable appointment of an ASSISTANT ENGINEER in the Mechanical and Electrical Engineering Branch of Production Department at London Headquarters. The duties of the selected applicant will include the preparation of technical specifications for sheet metal lockers and cabinets, and for mechanical boot cleaning and greasing equipment. He will also be responsible for inspection during manufacture at contractors' works and for the technical supervision of erection and installation of the equipment at the Board's sites throughout the country. Candidates should have had mechanical engineering and sheet metal experience. Knowledge of heating and mechanical ventilation plants would be an advantage.

Salary, according to qualifications and experience, will be between £450 and £750 per annum.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/643. Original testimonials should not be forwarded. Closing date 14th August, 1953. E9538

LONDON COUNTY COUNCIL

CIVIL AND STRUCTURAL ENGINEERING

CIVIL and STRUCTURAL ENGINEERING STAFF required for: (1) design of large civil engineering works in connection with main drainage and sewage purification; (2) general civil engineering work; (3) design and detailing of engineering structures; (4) surveying and road design and construction. Salaries or weekly pay as follows:—For (1) Civil Engineers (A.M.I.C.E. or equiv., with expce. in design of large sewage purification works an advantage), up to £1000 and £837; for (1) and (4), Civil Engineering Assistants, up to £837 and 201s., drawing office staff up to 207s. and 171s.; for (2) and (3), Civil or Structural Engineers, up to £837, Drawing Office Staff up to 171s. Commencing rates according to quals. and expce.; all posts pensionable.

Applications form (send s.a.e.) from Chief Engineer (53/27), County Hall, S.E.1, for return within 14 days from now. (756.) E9525

BRITISH ELECTRICITY AUTHORITY

LONDON DIVISION

THIRD ASSISTANT ENGINEER (MECHANICAL), GENERATION CONSTRUCTION DEPARTMENT

Applications are invited for the above superannuable post. Qualifications entitling to Grad. Membership of I.Mech.E. necessary, with experience in generating station layout practice, preparation of plant specifications and handling of plant contracts, &c. Salary and conditions of service in accordance with N.J.B. Agreement, Schedule C, Class A(i). Grade 5 equals £681 9s./£829 10s., rising to £927 3s. p.a., including London allowance.

Application may be made on form obtainable from Divisional Secretary, B.E.A., London Division, Generation House, Great Portland Street, W.1, and be received within 14 days of this advertisement. E9608

CHESTERFIELD, BOLSOVER AND CLOWNE WATER BOARD

APPOINTMENT OF TECHNICAL ASSISTANT

Applications are invited for the post of TECHNICAL ASSISTANT from Engineers experienced in mechanical and electrical engineering. Commencing salary within the scale £495–£595 per annum, according to qualifications and experience. National or B.O.T. Certificates or equivalent with workshop and drawing experience desirable. University Graduates in Engineering will be considered.

Further particulars can be obtained from the Engineer and Manager, New Beetwell Street, Chesterfield, to whom applications should be sent not later than 4th August, 1953.

RICHARD CLEGG,
Clerk.

8th July, 1953. E9500

NATIONAL COAL BOARD

NORTH-EASTERN DIVISION

RESIDENT ENGINEER

Applications are invited for the post of RESIDENT ENGINEER, Mechanical and Electrical, in the Planning and Reconstruction Department on the reconstruction schemes in the No. 4 (Carlton) Area, Yorkshire. Applicants should possess an Engineering Degree or an Associate of the Institution of Mechanical Engineers or its equivalent.

The post is permanent and the salary will be based on age, skill and experience, &c.

Applications, in writing, giving full particulars of age, qualifications, experience and positions held, should be sent to A. S. Barnes, Esq., Area Administrative Officer, National Coal Board, North-Eastern Division, No. 4 (Carlton) Area, Grimthorpe, Barnsley, to arrive not later than the 31st July. E

THE ENGINEER

JULY 24, 1953

Institution of Mining Engineers

LAST week the Institution of Mining Engineers held its summer meeting in Manchester. The members and ladies attending the meeting assembled on Tuesday evening, and on Wednesday morning, in the Whitworth Hall of the University, a welcome was expressed by Sir John Stopford, F.R.S., Vice-Chancellor of the University. This was followed by an address by Sir Hubert Houldsworth, Q.C., chairman of the National Coal Board, who spoke of the need for speeding up the mechanisation of the coal mines in this country. Sir Hubert said that the Coal Board's scheme of making grants to people who put forward practical suggestions to assist the coal mining industry was producing many useful suggestions. But, he added, the difficulty was to translate those suggestions into prototype machines and even then to get the prototypes made up quickly; also there were on the stocks many machines worthy of much more extensive trials than they had yet received. On Wednesday afternoon a paper entitled "The Planning of Shaft-Winding Equipment as a Basis for the Construction of Surface Plant at Collieries in the Ruhr," was presented by Dr. Ing. Hermann Schäfer. In his paper, Dr. Schäfer considered such matters as the depth of a shaft and the winding system, including the selection of the winder and the design of winding-rope carriers. He also dealt with the question of ventilation and the planning of transport routes and methods to and from the shaft. On Wednesday evening there was a civic reception by the Lord Mayor of Manchester in the Town Hall, and on Thursday works visits and a visit to the Point of Ayr Colliery occupied the day. The Institution's dinner was held on Thursday evening, at the Grand Hotel, Manchester, with the president, Professor J. Cecil Mitcheson, in the chair. The after-dinner speakers included Sir Joseph Hallsworth, chairman of the North Western Electricity Board, who proposed the toast "The Institution of Mining Engineers." In his speech, Sir Joseph urged that there should be more careful and more efficient use of coal. He said that in the first twenty-six weeks of this year the amount of coal consumed by the electricity supply industry was 5·7 per cent more than in the comparable period of last year, but the output of electricity was 8·4 per cent more than in the first twenty-six weeks of 1952.

Scrapping of the Brabazon Aircraft

THE decision was announced last Monday, by Mr. D. Sandys, Minister of Supply, to abandon the "Brabazon" aircraft project. The Minister stated that civil airlines and the fighting services could not now foresee the economic use either of the "Brabazon I," which had piston engines, or the still uncompleted "Brabazon II," which was to have been powered by turbo-propeller engines, and as it was believed that all possible technical information had been obtained on the completed aircraft, which had flown nearly 400 hours, the Minister continued, there could be no further justification for incurring further expense upon them. Both were to be dismantled. The Minister referred to the value of the knowledge gained from the project, particularly of the methods of reducing structural weight in large aircraft and the adoption of powered controls. He maintained that though costly the project had contributed considerably to the progress of British aviation. On the aircraft alone some £6,500,000 had been spent or committed, the hangar built specially for it and the runway at Filton also of abnormal proportions, had added another £6,000,000. The floor space made vacant at the manufacturers' works once the "Brabazons" have been scrapped, will be taken up by "Britannia" production. It was emphasised in the statement that this decision had no influence on the future of the "Princess" flying-boats.

Oil Pollution of the Sea

THE Committee on the Prevention of the Pollution of the Sea by Oil, which was appointed in September of last year by the Minister of Transport, published its report last week. The report considers the extent and effects of oil pollution and also the drift of oil in the sea, which was the subject of a number of experiments. With regard to the prevention of pollution from ships, the report touches upon long-term policy and also immediate action, and then deals with various categories of ships in three groups, namely, deep sea tankers, coastal tankers and dry cargo ships. For tankers present practice is noted and recommended procedure is set forth, together with main recommendations, while the sources of pollution peculiar to dry cargo ships are reviewed. Miscellaneous sources of discharge from ships' bilges are included in the report, which goes on to mention the sources of pollution other than those of ships. In the summary of recommendations the report suggests that new restrictions should be placed upon the discharge of persistent oils, such as crude, residual fuel and lubricating oils, outside territorial waters, and that the discharge of any oil within our territorial waters should continue to be prohibited. To enforce the first recommendation it is proposed that H.M. Government should obtain the agreement of other maritime countries to a date for the prohibition of discharge of persistent oils to become effective, and as an interim measure it suggests that a prohibited zone, as shown on a chart, should be arranged for British ships. Deep sea tankers leaving the United Kingdom should not discharge oily washings, &c., within the prohibited zone and, according to the report, those proceeding to this country should not discharge oily residues nearer than 100 miles from the coast. Coastal tankers should be permitted as a temporary measure to discharge oily ballast water outside territorial waters. Continuing, the report recommends that new dry cargo ships using tanks for both oil fuel and water ballast should be fitted with efficient separators and that existing ships should be similarly equipped as soon as possible. Other proposals touch upon the pumping of bilges, the disposal of oily residues, the question of the provision of port facilities for the reception of oily residues, the possibilities of chemical treatment and proposed amendments of the Oil in Navigable Waters Act, 1922.

Lloyd's Shipbuilding Returns

THE shipbuilding returns for the quarter ended June 30, 1953, have been published this week by Lloyd's Register of Shipping. At the end of June 317 steamships and motorships of 2,123,565 tons gross were under construction, and of this total 81 ships of 541,873 tons were fitting out and 236 of 1,581,692 tons were still to be launched. During the quarter the ships commenced numbered 61 of 350,323 tons, and those launched amounted to 62 of 399,438 tons, while a total of 65 ships representing 356,788 tons were completed. A total of 93 ships of 636,152 tons were under construction for registration abroad and represented 30 per cent of the tonnage building in this country and an increase of 58,336 tons over the previous quarter. Oil tankers totalled 110 ships of 1,212,052 tons and amounted to 57·1 per cent of the tonnage building. Plans were approved or material ordered for 2,391,281 tons gross, a decrease of 63,613 tons since the previous quarter, and of this total the proportion of oil tankers has fallen from 62·6 per cent to 60·7 per cent. Work in hand abroad, excluding China, Poland and Russia, amounted to 835 ships of 3,913,867 tons gross, an increase of 42,013 tons since March, and during the quarter 213 ships, of 1,006,640 tons were commenced, 239 ships of 905,501 tons were launched and 246 ships of 958,592 tons were completed, while 36 ships of 60,847 tons were suspended. The total of oil tankers under construction was 196 ships of 2,208,180 tons, an increase of 166,698 tons since March, and representing 56·4 per cent of the tonnage building abroad. In the world, a total of 1152 steamships and motorships representing 6,037,432 tons gross were under construction, of which 35·2 per cent was building in Great Britain and Northern Ireland. Oil tankers amounted to 306 ships of 3,420,232 tons, including 1,764,241 tons of steamships and 1,655,991 tons of motorships, and being 152,973 tons more than for the preceding quarter. The ships building in the world included 64 steamships and 109 motorships of between 10,000 and 15,000 tons, 36 steamships and 13 motorships of between 15,000 and 20,000 tons and 27 steamships and 3 motorships of between 20,000 and 30,000 tons each. Of the ships under construction throughout the world at the end of June, 3,815,961 tons, or 63·2 per cent, were under the inspection of Lloyd's Register.

Vehicle Braking

THE braking performance of motor vehicles and brake testing is the subject of a report issued this week by the Road Research Laboratory. The report discusses the part played in braking by a number of factors. Among these are characteristics of the braking system and other mechanical features of the vehicle, the frictional properties of the tyre and the road surface, the load distribution, unequal braking on the wheels, the driver's skill and the pressure he exerts on the brake pedal. The report also describes methods of measuring braking performance, and gives the results of tests on vehicles of different classes having brakes in proper adjustment, and on vehicles in use on the roads. The methods described for testing braking performance include the measurement of the braking distance, the maximum braking forces at the wheels and the maximum deceleration of the vehicle during braking. Each form of brake testing equipment has its advantages and disadvantages and with most the driver can influence the results of a brake test. Results of tests on vehicles having properly adjusted brakes show the best which can be achieved by vehicles of current design. Private cars with a good braking performance can achieve a braking distance of about 40ft from 30 m.p.h. This performance provides a standard of comparison for the results obtained in measurements of the braking performance of vehicles in use on the roads. With the help of the police and other authorities the brakes of representative samples of vehicles in use were tested. Many vehicles were found to have inadequate or badly adjusted brakes, and the report notes that 10 per cent of the cars tested could not stop within 100ft from 30 m.p.h., a distance which did not include any allowance for the reaction time of the driver. The report, entitled "The Braking Performance of Motor Vehicles and Brake Testing," is published by Her Majesty's Stationery Office, price 2s.

Some Problems in Flexural Testing

By F. A. BLAKEY, B.E. (Hons.), Ph.D., A.M.I.E., Aust.*

In the author's opinion, an aspect of testing technique which is too much neglected concerns the gap between mathematical stress analysis and experimental testing. The analysis which he gives below relates to possible errors caused by lack of conformity of the behaviour of the testing apparatus with the assumptions made about it ; it relates specifically to a series of tests on concrete beams, but has been kept as general as possible.

IN simple flexural tests on specimens of any material it is important to ensure that the actual conditions to which a specimen is subjected in the testing machine conform as closely as possible the mathematical assumptions made about them. Thus it is assumed that the loading points and supports for a beam apply only vertical forces and that at such points a beam should be free from any restraint against rotation or movement parallel to the axis of the beam. It is also assumed that any applied loads are uniformly distributed across the beam at the neutral axis so that no torsional stresses occur.

Although it is widely recognised that actual testing apparatus does not conform to some or all of these postulates, no analysis appears to have been made of the extent of errors that are likely to follow if the degree to which the apparatus fails to satisfy the ideal conditions is not taken into account in the calculations. Such an analysis is presented here.

This aspect of flexural testing was brought to the author's notice by some readings taken during a series of tests on plain and reinforced concrete beams under repeated

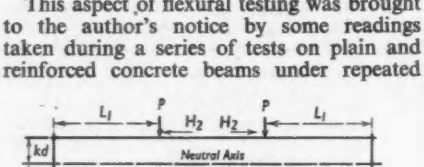

Fig. 1

loads. Thus, although the subsequent analysis has been kept as general as possible, it will be found to have been related specifically to these materials at certain points.

No attempt has been made to provide experimental evidence related to the results of the analysis because at the time this would have entailed too much of a digression from the research in progress and the immediate difficulties had been quickly overcome. However, it is hoped that this theoretical examination of the errors that can arise will emphasise the need for a thorough checking of the testing apparatus and a quantitative measurement of unwanted restraints in cases where it is not considered practicable to eliminate them.

The mathematical theory used is the elementary theory of elasticity, so that the validity of the results is dependent on the accuracy of the elementary theory for the tests in question. Thus it must be assumed that the beams would not be classified as deep beams, for which the elementary treatment is not valid, and that the duration of the test is short enough to avoid any appreciable creep deflection.

Further, the deflections must be small enough for the arc length of the deflected undersurface of the beam to remain sensibly equal to the chord between the points of support. The concentrated loads at the loading points and at the supports will produce local deviations in stress from that calculated by the elementary theory of elasticity. If the tensile stress at the lower fibre is written

$$\sigma_t=\sigma'_t+\sigma''_t$$

where σ'_t is the value calculated from elementary theory and σ''_t is the correction from a more refined analysis[1, 2] it appears that σ''_t is not likely to be more than ± 3 per cent of σ'_t for beams which would not be classified as deep beams.

In a material such as concrete there will also be some deviation of the stresses from the theoretical value because of the varying elastic properties of the material. Very little appears to be known about the distribution of the elastic properties throughout a specimen or mass of concrete, but from published figures[3, 4] on the variance of test results on concrete specimens an estimate is made that these "vagabond" stresses, as Rôs has called them, are not more than ± 5 per cent of the theoretical.

Beams of Small Deflection

Fig. 1 shows a simply supported beam subjected to concentrated loads spaced equally distant from the centre. The supports and loading points may exert some horizontal restraint given by forces H_1 and H_2. It is assumed that the two forces H_1 are equal, as are the forces H_2, but H_1 and H_2 are not necessarily equal.

The problem may be treated in two ways differing in practice on whether it is found more convenient to measure the deformations of a beam or the horizontal forces H_1 and H_2 ; the former analysis is somewhat longer. Both methods are presented here.

Method 1.

M = Bending moment at any cross-section distance x from the support.
E = Modulus of elasticity of material.
I = Moment of inertia of cross-section.
F = Horizontal thrust at any cross-section.
A = Area of section.

Referring to Fig. 1, when $0 \leqslant x \leqslant L_1$,

$$M=Px-H_1fd \quad . \quad . \quad . \quad . \quad (1a)$$

$$\frac{\partial M}{\partial H_1}=-fd$$

$$F=H_1 \text{ and } \frac{\partial F}{\partial H_1}=1,$$

when

$$L_1 \leqslant x \leqslant (L-L_1),$$

$$M=PL_1-H_1fd-H_2kd \quad . \quad . \quad . \quad . \quad . \quad (1b)$$

$$\frac{\partial M}{\partial H_1}=-fd \text{ and } \frac{\partial M}{\partial H_2}=-kd,$$

$$F=H_1-H_2,$$

$$\frac{\partial F}{\partial H_1}=1 \text{ and } \frac{\partial F}{\partial H_2}=-1.$$

The strain energy due to flexure and thrust of the beam is

$$U=\int_0^L \frac{M^2}{2EI}\,dx+\int_0^L \frac{F^2}{2EA}\,dx$$

and $\frac{\partial U}{\partial H_1}$ and $\frac{\partial U}{\partial H_2}$ give the movements of the points of application of the forces H_1 and H_2 respectively, in the line of these forces.

For complete horizontal restraint

$$\frac{\partial U}{\partial H_1}=\frac{\partial U}{\partial H_2}=0.$$

or for partial restraint

$$\frac{\partial U}{\partial H_1}=-v$$

$$\frac{\partial U}{\partial H_2}=-w$$

v and w are given negative signs because they will be movements in the opposite directions to those which the forces at these points have been assumed to act. That is,

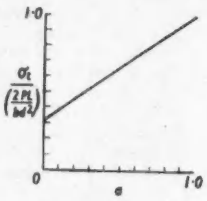

Fig. 2

H_1 is assumed to act towards the centre of the beam, and if this direction is positive v will be negative if it is a movement away from the centre, as it will be. Therefore

$$\frac{\partial U}{\partial H_1}=\int_0^L \frac{M}{EI}\cdot\frac{\partial M}{\partial H_1}\,dx+\int_0^L \frac{F}{EA}\cdot\frac{\partial F}{\partial H_1}dx=-v$$

$$\frac{\partial U}{\partial H_2}=\int_0^L \frac{M}{EI}\cdot\frac{\partial M}{\partial H_2}\,dx+\int_0^L \frac{F}{EA}\cdot\frac{\partial F}{\partial H_2}dx=-w$$

. . . . . (2)

If there is no horizontal restraint on a beam it may be shown that the increase in length of the extreme tension fibre is

$$\Delta L=\frac{P\,.\,fd\,.\,(L-L_1)}{EI}$$

and the contraction between the loading points is

$$\frac{P\,.\,kd\,.\,(L-2L_1)}{EI}.$$

We may then write

$$v=a\,.\,\frac{P\,.\,fd}{EI}\,(L-L_1)$$

$$w=b\,.\,\frac{P\,.\,kd}{EI}\,(L-2L_1).$$

These expressions may be substituted in equations (2) and the integrals evaluated by means of equations (1), whence it follows that

$$H_1\left(f+\frac{I}{Afd^2}\right)-H_2\,\frac{(I-Afkd^2)(1-2\lambda)}{A\,.\,fd^2}=\frac{P\lambda L}{d}(1-a)(1-\lambda)$$

$$H_1\left(f-\frac{I}{Akd^2}\right)+H_2\left(k+\frac{I}{Akd^2}\right)=\frac{P\lambda L}{d}(L_1-b)$$

. . . . . (3)

where

$$L_1=\frac{\lambda}{L}\,.$$

In any specific case these equations may be solved numerically.

If the loading is applied at the third points ($\lambda=\frac{1}{3}$) and the restraint at the supports is complete ($a=0$), but zero at the loading points ($H_2=0$), then

$$H_1=\frac{2PL}{9\left(fd+\frac{I}{Afd}\right)}.$$

Alternatively, if $b=0$ and $H_1=0$,

$$H_2=\frac{PL}{3\left(kd+\frac{I}{Akd}\right)}.$$

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For a rectangular beam, when $f=k=0{\cdot}5$ these two solutions become

$$H_1=\frac{PL}{3d} \text{ and } H_2=\frac{PL}{2d}.$$

From the expression for the stress

$$\sigma=\frac{F}{A}\pm\frac{My}{I}$$

the maximum tensile stress at the centre is $\frac{2PL}{3bd^2}$ in the first case instead of $\frac{2PL}{bd^2}$, as would be calculated if the horizontal forces were not taken into account. This is a reduction of 66⅔ per cent. In the second case the maximum tensile stress is $\frac{PL}{4bd^2}$ instead of $\frac{2PL}{bd^2}$, a reduction of 87½ per cent.

These are, of course, extreme cases which would certainly not occur in practice if even the most elementary precautions were taken against unwanted restraints.

In Fig. 2 is given the relation between the tensile stress and a, if $H_2=0$, for a rectangular beam when $f=k=0{\cdot}5$ and $\lambda=\frac{1}{3}$. This shows the variation with a of the ratio of σ_t to $\frac{2PL}{bd^2}$, that is, the ratio of the actual stress occurring to that calculated neglecting any horizontal restraints.

The quantity a is the ratio of the actual end extension occurring to that which would occur if there were no restraint at the supports. The measurements of the end extension may easily be made during the test by horizontal dial gauges in positions corresponding to H_1 in Fig. 1. It appears desirable that the measurements of end extension should not be made right up to failure, as local cracking or yielding in the beam may give spurious values. In reinforced concrete beams, bond failure between the steel and concrete can also lead to measured extensions in excess of those calculated.

If this theory is applied to a specific case of a specimen of concrete the calculated figure for the extension of the beam under normal loads will most probably be in error because of the uncertainty over the value of the stiffness EI. It is known that the "modulus of rupture" of concrete calculated from beam tests is higher than its tensile strength otherwised determined, and it has been suggested[5] that this may be explained by the assumption of a stress distribution curve of order higher than one in the tension zone of the beam. However, the distribution of compressive stress on the other side of the neutral axis is considered linear since the deformations at failure of an unreinforced concrete beam are so small.

It will be shown here that if the stress distribution in the tension zone of the beam is assumed to be a curve, then the preceding

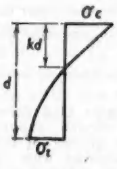

Fig. 3

analysis still holds with only modification of the form of I and the value of E.

Fig. 3 shows the assumed stress distribution in a beam subjected to pure moment. The forces C and T are the compressive and tensile resultants in the beam, and it is assumed that the curved tensile stress distribution is of the order t, with a vertical tangent at the bottom.

$$T=\frac{t}{t+1}\cdot\sigma_t(1-k)bd$$

$$C=\frac{\sigma_\rho kbd}{2}$$

$$\frac{\sigma_\rho}{k}=\frac{t\sigma_\rho}{1-k}.$$

For pure moment $T=C$ and by substituting the above expressions for T, C and σ_ρ it may be shown that

$$\frac{k^2}{(1-k)^2}=\frac{t+1}{2}$$

or

$$k=\frac{\alpha}{1+\alpha}$$

where

$$\alpha=\sqrt{\left\{\frac{2}{1+t}\right\}}.$$

If jd is the moment arm of the couple $T-C$ it may be shown that

$$j=\frac{2}{3}k+(1-k)\left(\frac{t+3}{2(t+2)}\right)$$

and that

$$\frac{M}{bd^2\sigma_t}=\frac{\alpha^2 t}{(1+\alpha)^2}\left(\frac{\alpha}{3}+\frac{(t+3)}{4(t+2)}\right).$$

For simplicity let this term be β. Consider now an element of length ds of the beam. In Fig. 4 if AE is drawn parallel to BD then CE

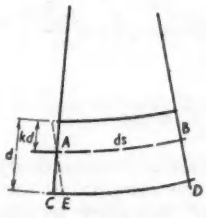

Fig. 4

represents the extension of the bottom fibre of the beam; that is

$$CE=\epsilon_t ds,$$

also

$$\frac{CE}{(1-k)d}=\frac{ds}{R},$$

where R is the radius of curvature.

Therefore

$$\frac{\epsilon_t}{(1-k)d}=\frac{1}{R}=\frac{d^2y}{dx^2}$$

but

$$\epsilon_t=\frac{t\sigma_t}{E}=\frac{t}{E}\frac{Mt}{bd^2\beta}.$$

Therefore

$$\frac{d^2y}{dx^2}=\frac{Mt}{\beta bd^3(1-k)E}=\frac{M}{EI'}$$

where E is the initial tangent modulus of elasticity, which may be determined from vibrating beam tests and I' is defined as

$$\frac{\beta bd^3(1-k).}{t}$$

If a cubic stress distribution is assumed ($t=3$) it follows that

$$I'=0{\cdot}054bd^3$$

instead of the usual

$$I=0{\cdot}0833bd^3.$$

This calculation leads to a reduced value for the stiffness of the beam if the same value of E is used. I' may be substituted for I in equations (2) and the analysis given previously need not be altered.

Method 2.—Yet another treatment may be considered for which the theory is much simpler than that already presented, but which in practice seems likely to lead to as much uncertainty as ever, except in some special cases. It is assumed that there is a linear relationship between the vertical and horizontal forces at the loading points or supports, similar to a coefficient of friction. This relationship would have been determined for the apparatus beforehand.

Thus if μ is the coefficient of friction at the supports and ν is the coefficient at the loading points, then referring to Fig. 1 the moment over the centre section is

$$M=PL_1-\mu Pfd-\nu Pkd$$

and the thrust

$$F=\mu P-\nu P=(\mu-\nu)P.$$

From these expressions and the equation

$$\sigma=\frac{F}{A}\pm\frac{My}{I}$$

the stresses in a specimen may be calculated.

However, there would appear to be numerous practical difficulties in the way of determining this μ and ν accurately. For any instance where sliding might take place between the beam and the support it is the coefficient of friction between the two materials that will be applicable. For materials such as concrete this will probably vary widely from one specimen to another. If the point of contact is fixed, but a rolling or sliding of the support relative to the bed-plate occurs, the values of μ and ν will depend on the extent of the lubrication of the surface on which the movement occurs, and if this surface is lubricated it is unlikely that μ and ν will be constant under increasing pressure. These difficulties may be insignificant for tests on unreinforced concrete where the deformations are small, but for reinforced concrete where the deflections are much greater it is to be expected that the uncertainty would still be considerable.

Beams of Larger Deflection

An attempt was made to refine the original analysis by introducing moment terms depending on H_1 and H_2 and the deflection of the beam. However, because of the complexity of the equations that developed it appeared impossible to formulate two equations similar to (3). The determination of the deflected shape of the beam is presented in the appendix for the special case where $L_1=\frac{L}{3}$.

Instead of equations (1)

$$0<x<L$$

$$M=-\frac{EId^2y}{dx^2}=Px-H_1(fd-y)$$

and

$$L_1<x<L-L_1$$

$$M=-\frac{EId^2y}{dx^2}=PL_1-H_1(fd-y)-H_2(kd+\overline{y-y_1})$$

where

$$y_1=y \text{ when } x=L_1.$$

From the appendix the deflection curve of the beam may be established for a specific case. This expression should then be substituted in the above equations, which in turn should be substituted in equations (2). However, in evaluating $\frac{\partial M}{\partial H_1}$ and $\frac{\partial M}{\partial H_2}$ it must be remembered that the "constants" of the deflection equation are dependent on H_1 and H_2. This further complexity would seem to make the refinement impossible.

Torsional Stresses

Owing to irregularity of the moulds, warping of the specimen or some error in alignment of the testing apparatus it is possible that the loading points or supports may not bear evenly across the specimen and so shearing stresses due to torsion may be introduced. These shearing stresses, in combina-

tion with the normal tensile stress on the undersurface of the beam, may reduce the ultimate flexural strength of the member.

The maximum torsional moment which may exist theoretically is $\frac{Pb}{2}$, when the normal force bears on one edge of the beam.

The torsion of rectangular sections is treated by Timoshenko,[2] who gives the stress function

$$\phi=\frac{8G\theta b}{\pi^3}\sum_{n=1,3,5}\frac{1}{n^3}[-1]^{\frac{n-1}{2}}\times\left(1-\frac{\cos\frac{n\pi y}{b}}{\cosh\frac{n\pi d}{2b}}\right).\cos\frac{n\pi x}{b}$$

where G is the modulus of rigidity of the material and θ is the angle of twist per unit length.

Using the co-ordinates shown in Fig. 5, the maximum shearing stress on the under-

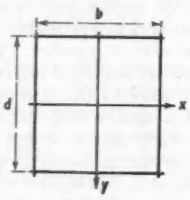

Fig. 5

surface will be at the centre of this face and will be obtained from the expression for τ_{zz}.

$$\tau_{zz}=\frac{\partial\phi}{\partial y}$$

$$=\frac{8G\theta b}{\pi^2}\sum_{n=1,3,5}\frac{1}{n^2}[-1]^{\frac{n+1}{2}}\frac{\sinh\frac{n\pi y}{b}}{\cosh\frac{n\pi d}{2b}}.\cos\frac{n\pi x}{b}.$$

When $x=0$, $y=\frac{d}{2}$

$$\tau_{zz}=\tau'=\sum_{n=1,3,5}\frac{1}{n^2}[-1]^{\frac{n+1}{2}}\tanh\frac{n\pi d}{2b}.$$

Here we shall consider only beams for which $d>b$.

Then for $d>b$ and $n>1$

$$0{\cdot}95<\tanh\frac{n\pi d}{2b}<1$$

and, therefore, as an approximation this term will be taken to be unity.

The series $\sum_{n=1,3,5}[-1]^{\frac{n+1}{2}}.\frac{1}{n^2}$ does not appear to have a simple closed form, but it is rapidly convergent. The sum of the first eight terms is $0{\cdot}9140$ or $\frac{\pi^2}{10{\cdot}80}$.

Therefore

$$\tau'=0{\cdot}74G\theta b.$$

Timoshenko also shows that the torsional moment

$$M_t=k_1G\theta b^3d,$$

where k_1 is a factor depending on $\frac{d}{b}$ and for which a table is given.

Therefore

$$\tau'=\frac{0{\cdot}74M_t}{k_1b^2d}=\frac{0{\cdot}37P}{k_1bd}$$

if

$$M_t=\frac{Pb}{2}$$

the maximum tensile stress σ_t is given by:

$$\sigma_t=\frac{6PL_1}{bd}$$

then

$$\frac{\tau'}{\sigma_t}=\frac{0{\cdot}06d}{k_1L}$$

This is shown graphically in Fig. 6. On

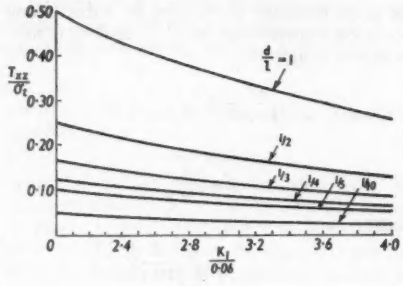

Fig. 6

the undersurface of the beam the principal tensile stress

$$p=\frac{\sigma_t}{2}+\sqrt{\left\{\left[\frac{\sigma_t}{2}\right]^2+\tau_{zz}^2\right\}}$$

$$\frac{p}{\sigma_t}=\tfrac{1}{2}+\sqrt{\left\{\tfrac{1}{4}+\left(\frac{\tau_{zz}}{\sigma_t}\right)^2\right\}}$$

If p exceeds σ_t by 5 per cent,

$$1{\cdot}05=\tfrac{1}{2}+\sqrt{\left\{\tfrac{1}{4}+\left(\frac{\tau_{zz}}{\sigma_t}\right)^2\right\}},$$

from which

$$\frac{\tau_{zz}}{\sigma_t}=0{\cdot}224.$$

Thus if we accept the uncertainty of ±5 per cent, which was proposed at the beginning, the effect of unwanted torsional stresses cannot be significant for values of $\frac{\tau_{zz}}{\sigma_t}<0{\cdot}224$. From Fig. 6 it can be seen that torsional stresses may be neglected for values of $\frac{d}{L_1}$ less than a half when $d>b$.

Appendix

Referring again to Fig. 1, when

$$0<x<\frac{L}{3}$$

$$M=\frac{Px}{2}-H_1(fd-y)$$

$$EId^2y/dx^2=-\frac{Px}{2}+H_1(fd-y) \quad . \quad . \quad . \quad . \quad . \quad (1a)$$

the solution of which is

$$y=C_1\cos\alpha x+C_2\sin\alpha x+fd.-\frac{\beta^2}{\alpha^2}x \quad . \quad . \quad . \quad . \quad . \quad . \quad (1b)$$

where

$$\alpha^2=\frac{H}{EI};\quad \beta^2=\frac{P}{2EI}$$

since

$$y=0 \text{ at } x=0,$$
$$C_1=-fd$$

and

$$y=fd(1-\cos\alpha x)+C_2\sin\alpha x-\frac{\beta^2}{\alpha^2}x \quad . \quad . \quad (2)$$

When

$$\frac{L}{3}<x<\frac{L}{2}$$

$$M=\frac{PL}{6}-H_1(fd-y)-H_2(kd+\overline{y-y_1}),$$

where

$$y=y_1 \text{ when } x=\frac{L}{3}$$

therefore

$$\frac{EId^2y}{dx^2}=-\frac{PL}{6}+H_1(fd-y)+H_2(kd+y-y_1)$$

for which the solution is

$$y=C_3\cos x\sqrt{(\alpha^2-\gamma^2)}+C_4\sin x\sqrt{(\alpha^2-\gamma^2)}-\frac{\beta^2}{\alpha^2-\gamma^2}\cdot\frac{L}{3}+\frac{\alpha^2fd}{\alpha^2-\gamma^2}+\frac{\gamma^2(kd-y_1)}{\alpha^2-\gamma^2}$$

where

$$\gamma^2=\frac{H_2}{EI}$$

when

$$x=\frac{L}{2},\ \frac{dy}{dx}=0$$

and therefore

$$C_4=C_3\tan\frac{\delta L}{2}$$

thus if

$$\delta^2=\alpha^2-\gamma^2$$

$$y=C_3(\cos\delta x+\tan\frac{\delta L}{2}.\sin\delta x)-\frac{\beta^2}{\delta^2}\cdot\frac{L}{3}+\frac{\alpha^2}{\delta^2}.fd+\frac{\gamma^2(kd-y_1)}{\delta^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

C_2 and C_3 may be found by equating the values for the slope and deflection at $x=\frac{L}{3}$. The results are very cumbersome and complicated and are given here as determinants.

$$C_2=\frac{\begin{vmatrix}\frac{\beta^2}{\alpha^2}-\alpha fd.\sin\frac{\alpha L}{3} & Z\\ X & -Y\end{vmatrix}}{\begin{vmatrix}\alpha\cos\frac{\alpha L}{3} & Z\\ \sin\frac{\alpha L}{3} & -Y\end{vmatrix}}$$

$$\text{and } \delta C_3=\frac{\begin{vmatrix}\alpha\cos\frac{\alpha L}{3} & \frac{\beta^2}{\alpha^2}-\alpha fd.\sin\frac{\alpha L}{3}\\ \sin\frac{\alpha L}{3} & X\end{vmatrix}}{\begin{vmatrix}\alpha\cos\frac{\alpha L}{3} & Z\\ \sin\frac{\alpha L}{3} & -Y\end{vmatrix}}$$

where

$$X=\left(f+\frac{\gamma^2}{\alpha^2}\right)d-fd\left(1-\cos\frac{\alpha L}{3}\right)$$

$$Y=\frac{\delta}{\alpha^2}\left(\cos\frac{\delta L}{3}+\tan\frac{\delta L}{2}.\sin\frac{\delta L}{3}\right)$$

$$Z=\frac{\delta^2}{\alpha^2}\left(\sin\frac{\delta L}{3}-\tan\frac{\delta L}{2}.\sin\frac{\delta L}{3}\right)$$

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Sweden's Iron and Ore Exports.—According to *The Anglo-Swedish Review*, exports of iron ore from Sweden in the first quarter of this year amounted to 2,700,000 tons, compared with 2,900,000 tons in the corresponding period of last year. Exports of pig iron also decreased, to only 2700 tons from 15,600 tons in the first quarter of last year, but exports of iron and steel in the first quarter of this year totalled 48,100 tons, compared with 41,800 tons in the first quarter of last year. Imports decreased considerably, malleable iron scrap from 23,600 tons in the first quarter of last year to 2300 tons, pig iron from 23,600 tons to 6100 tons and hot and cold rolled goods from 247,000 tons to 126,100 tons. Pig iron production in the first quarter of this year decreased from 261,400 tons to 240,400 tons, though ingot production increased from 411,200 tons to 446,100 tons, and hot rolled iron and steel output rose from 266,300 tons to 302,700 tons. It is stated that orders in hand at the ironworks are still substantial although there was some decline over the first quarter.

The "Intrinsic Efficiency" of a Flow Type Air Compressor

B. DOWNS, M.Eng., A.M.I.Mech.E.

A distinction exists between the application of the term isentropic efficiency to flow type air compressors and air turbines respectively. By consideration of the energy of the air ideally available for conversion into mechanical form the concept of "intrinsic efficiency" of the compressor is established and is then compared with the isentropic and polytropic efficiencies. Illustrations of the processes are made on the $T\phi$ diagram, and whilst air is assumed to have constant specific heat the theory remains valid if variation in the specific heats of air is taken into account. Calculations, however, are modified and are most easily effected by the use of air tables.

A COMPRESSED air power transmission system is shown in Fig. 1, in which W_i units of work per pound of air are put into the compressor shaft and W_o units of work per pound of air are obtained from the turbine shaft.

If the compressor efficiency$=\eta_c$, storage and transmission efficiency$=\eta_s$, and the turbine efficiency$=\eta_T$, then the following relationship might reasonably be expected :

$$W_i \times \eta_c \times \eta_s \times \eta_T = W_o \quad . \quad . \quad . \quad . \quad (1)$$

To simplify examination of this equation the arrangement shown in Fig. 2 is considered

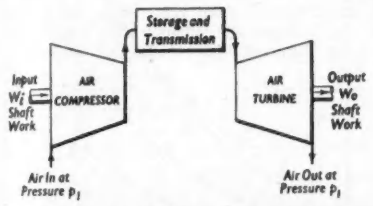


Fig. 1—Compressed Air Power Transmission System

in which the compressor delivers directly into the turbine inlet, this being equivalent to putting $\eta_s=1$ in equation (1).

For this arrangement equation (1) becomes

$$W_i \times \eta_c \times \eta_T = W_o \quad . \quad . \quad . \quad . \quad (2)$$

Referring to Fig. 3, for the compressor, per pound of air,

$$W_i = \text{enthalpy gain during compression} = I_2 - I_1 = c_p(T_2 - T_1) \quad . \quad . \quad . \quad . \quad (3)$$

For the turbine, per pound of air,

$$W_o = I_2 - I_3 = c_p(T_2 - T_3) \quad . \quad . \quad . \quad . \quad (4)$$

and substituting from equations (3) and (4) in equation (2) gives

$$\eta_c \times \eta_T = \frac{T_2 - T_3}{T_2 - T_1} \quad . \quad . \quad . \quad . \quad (5)$$

Also, isentropic efficiency of compressor

$$\eta_{c_a} = \frac{T_{2'} - T_1}{T_2 - T_1} \quad . \quad . \quad . \quad . \quad (6)$$

isentropic efficiency of turbine

$$\eta_{T_a} = \frac{T_2 - T_3}{T_2 - T_{3'}} \quad . \quad . \quad . \quad . \quad (7)$$

where $T_{2'}$ is the temperature after isentropic* compression from T_1 and $T_{3'}$ is the temperature after isentropic expansion from T_2.

Comparing these with the requirements of compressor and turbine efficiency as expressed in equation (5) gives

$$\eta_{c_a} \times \eta_{T_a} = \frac{T_{2'} - T_1}{T_2 - T_{2'}} \times \frac{T_2 - T_3}{T_2 - T_1} = \frac{T_{2'} - T_1}{T_2 - T_{3'}} \times \eta_c \times \eta_T \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and

$$T_1 = T_{2'} \times \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}} \quad . \quad . \quad . \quad . \quad (9)$$

$$T_{2'} = T_2 \times \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}} \quad . \quad . \quad . \quad . \quad (10)$$

* Isentropic processes are considered as adiabatic and isentropic processes throughout.

giving

$$\frac{T_{2'} - T_1}{T_2 - T_{3'}} = \frac{T_{2'}\left[1 - \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}\right]}{T_2\left[1 - \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}\right]} = \frac{T_{2'}}{T_2} \quad (11)$$

and since T_2 only equals $T_{2'}$ for isentropic compression, then the isentropic efficiencies

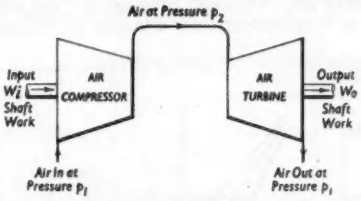


Fig. 2—Compressor Delivering Directly into Turbine Inlet

do not meet the general requirements of equation (2).

If the air is expanded isentropically back to the base pressure p_1, from 2 to 3', $I_2 - I_{3'}$ represents the maximum output of work, since it is achieved by a reversible process. $I_2 - I_{3'}$ may therefore be regarded as the portion of energy of the air at state 2 available for conversion to mechanical form.

The isentropic efficiency of the turbine represents

$$\frac{\text{Portion of air energy actually converted into mechanical form}}{\text{Portion of air energy available for conversion into mechanical form}}$$

The soundness of this definition does not apply in the case of the compressor, where the isentropic efficiency represents

$$\frac{\text{The energy required to compress isentropically from pressure } p_1 \text{ to } p_2}{\text{The actual energy used to compress from pressure } p_1 \text{ to } p_2}$$

Since in the compression achieved in all flow machines the portion of the air energy at discharge available for conversion to mechanical work always exceeds the energy required for isentropic compression, the weakness of this definition becomes apparent.

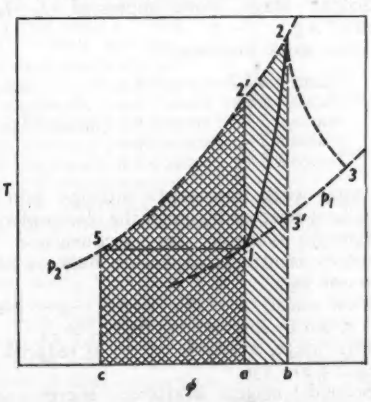


Fig. 3—Isentropic Efficiency

On the assumption that it is almost impossible to revise accepted terminology, the author puts forward the term "intrinsic efficiency" of air compressors and defines it as

$$\frac{\text{Output of compressor measured by the energy of the discharge air available for conversion into mechanical form}}{\text{Input to compressor measured by the actual energy expended in the compression}}$$

or "intrinsic efficiency" of compressor

$$= \eta_{c_i} = \frac{I_2 - I_{3'}}{I_2 - I_1} = \frac{T_2 - T_{3'}}{T_2 - T_1} \quad . \quad . \quad (12)$$

Then

$$\eta_{c_i} \times \eta_{T_a} = \frac{I_2 - I_{3'}}{I_2 - I_1} \times \frac{I_2 - I_3}{I_2 - I_{3'}} = \frac{I_2 - I_3}{I_2 - I_1} = \frac{W_o}{W_i} \quad . \quad (13)$$

The combination of intrinsic efficiency of compressor and isentropic efficiency of the turbine therefore satisfy the requirements of equation (2).

A clear picture of what is involved, together with a comparison of isentropic, polytropic and "intrinsic" efficiencies is obtained by referring to areas on the $T\phi$ diagram. Any area beneath a path line on the $T\phi$ diagram represents $\int T d\phi$, which can be equated to a heat quantity only for a reversible change along the path. The compression occurring in a flow machine is, however, irreversible and it is necessary to substitute an equivalent reversible process. The irreversible adiabatic compression in the actual machine is replaced by a non-adiabatic reversible compression during which heat is added to the air at a rate pro-

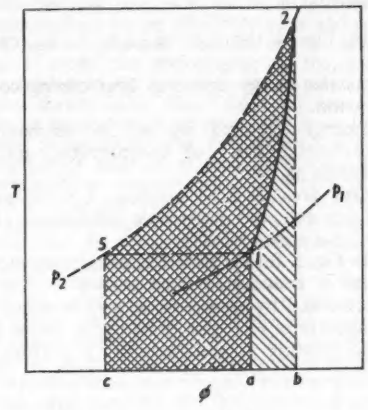


Fig. 4—Polytropic Efficiency

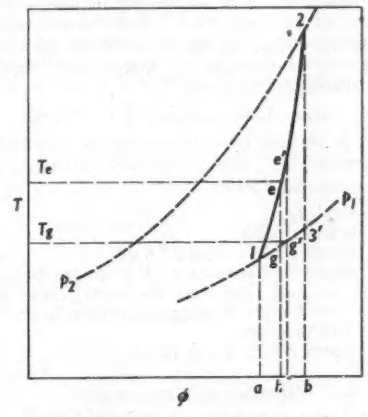


Fig. 5—Derivation of Available Portion of Total Heat Added

portional to that at which mechanical work is being impressed upon it.

In Fig. 3 the total work of compression $=I_2-I_1$=area $c\,5\,2\,b$, the work of isentropic compression$=I_{2'}-I_1$=area $c\,5\,2'\,a$, and the isentropic efficiency=area $c\,5\,2'\,a$/area $c\,5\,2\,b$.

In Fig. 4 the area $a\,1\,2\,b=\int_1^2 T d\phi$ represents the energy added as heat during compression.

Energy acquired by air in mechanical form=total work of compression−energy acquired as heat.

Or area $c\,5\,2\,1\,a$=area $c\,5\,2\,b$−area $a\,1\,2\,b$ and the polytropic efficiency=area $c\,5\,2\,1\,a$/area $c\,5\,2\,b$.

In Fig. 5, for the path 1 2 consider the increment of heat added from e to e'. This is represented by area $h\,e\,e'\,h'$ and is added at temperature T_e. The pressure is above the base pressure p_1 and therefore a portion of

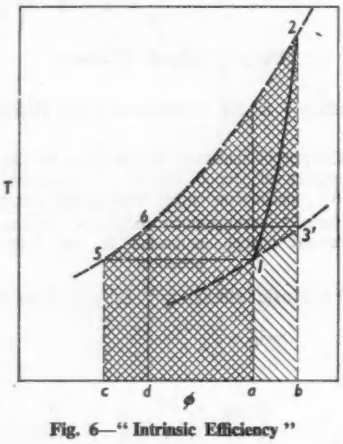


Fig. 6—"Intrinsic Efficiency"

this heat is available. If T_g is the temperature at the end of isentropic expansion to pressure p_1, the fraction available$=T_e-T_g/T_e=eg/eh$. Integrating from 1 to 2, the available portion of the total heat added (represented by area $a\,1\,2\,b$) is given by area $1\,2\,3'$.

Adding to this the area $c\,5\,2\,1\,a$ (Fig. 6), representing energy impressed in mechanical form, gives area $c\,5\,2\,3'\,1\,a$, which represents the energy of the air as delivered available for conversion to mechanical work; i.e "intrinsic efficiency"

$=$area $c\,5\,2\,3'\,1\,a$/area $c\,5\,2\,b$ (Fig. 6).

This is verified by considering the isentropic expansion $2\,3'$, which converts into work all the available energy

$=I_2-I_{3'}$,
=area $d\,6\,2\,b$,
=area $c\,5\,2\,b$−area $c\,5\,6\,d$,
=area $c\,5\,2\,b$−area $a\,1\,3'\,b$ (since constant pressure lines have the same profile and are merely displaced horizontally on the $T\phi$ diagram),
=area $c\,5\,2\,3'\,1\,a$ as before.

Numerical Comparison

Assuming conditions, $T_1=520$°R (° F. abs.)
$p_1=15$ p.s.i.a.
$p_2=60$ p.s.i.a.
isentropic index, $\gamma=1{\cdot}4$,
compression index, $n=1{\cdot}6$,

$$T_2=\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}\times T_1=876\text{°R}.$$

$$T_{2'}=\left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}}\times T_1=773\text{°R},$$

$$T_{3'}=\left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}\times T_2=588\text{°R}.$$

$$\text{Isentropic efficiency}=\frac{T_{3'}-T_1}{T_2-T_1}=0{\cdot}711.$$

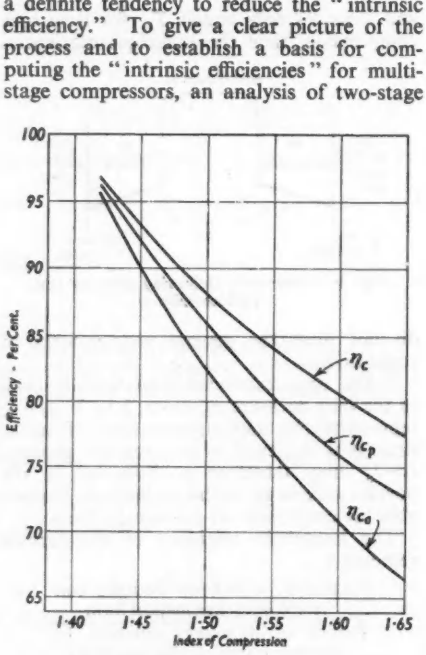
$$\text{Polytropic efficiency}=\frac{1-1/\gamma}{1-1/n}=0{\cdot}763.$$

$$\text{"Intrinsic" efficiency}=\frac{T_2-T_{3'}}{T_2-T_1}=0{\cdot}809.$$

In Fig. 7 the variation of the three efficiencies with the value of n is plotted for the same conditions.

Multi-Stage Compression with Intercooling

The effect of intercooling is to reduce the work required for subsequent stages of compression and to reduce the value of the overall compression index n to a value nearer to γ. Both the isentropic and polytropic efficiencies show an increase. An increase in "intrinsic efficiency" is also effected, but since the intercooler must be considered an integral part of the compressor, the reduction in availability produced by intercooling has a definite tendency to reduce the "intrinsic efficiency." To give a clear picture of the process and to establish a basis for computing the "intrinsic efficiencies" for multi-stage compressors, an analysis of two-stage



Assumed conditions for compressor:

Inlet temperature	60 deg. Fah.
Pressure ratio...	4 to 1
Isentropic index	γ 1·40

Fig. 7—Comparison of "Intrinsic," Polytropic and Isentropic Efficiencies

compression with partial intercooling follows.

Referring to Fig. 8, work input to compressor,

First stage, work impressed$=I_2-I_1$=area $b\,a\,2\,f$.

Second stage, work impressed$=I_4-I_3=$ area $c\,7\,4\,g$.

Total work impressed

$=$area $b\,a\,2\,f$+area $c\,7\,4\,g$
$=$area $h\,5\,6\,k$+area $c\,7\,4\,g$
$=$area $h\,5\,7\,c$+area $c\,7\,6\,k$+area $c\,7\,4\,g$
$=$area $h\,5\,4\,g$+area $c\,7\,6\,k$
$=$area $h\,5\,4\,g$+area $e\,3\,2\,f$

or total work impressed=enthalpy gain of air+heat rejected by air in the intercooler.

Energy available for reconversion to work by isentropic expansion back to base pressure p_1:

First stage, available energy=area $b\,a\,2\,m\,1\,d$, but by intercooling from 2 to 3.

First stage, available energy is reduced to area $b\,a\,3\,p\,1\,d$.

Second stage, available energy=area $c\,7\,4\,q\,p\,e$.

Total available input

$=$area $b\,a\,3\,p\,1\,d$+area $c\,7\,4\,q\,p\,e$
$=$area $b\,a\,r\,d$+area $1\,r\,3\,p$+area $c\,7\,4\,q\,p\,e$
$=$area $h\,5\,s\,t$+area $1\,r\,3\,p$+area $c\,7\,4\,n\,r\,d$ +area $d\,r\,3\,e$+area $p\,3\,n\,q$
$=$area $h\,5\,s\,t$+area $1\,r\,3\,p$+area $c\,7\,4\,n\,r\,d$ +area $t\,s\,7\,c$+area $p\,3\,n\,q$
$=$area $h\,5\,4\,n\,r\,d$+area $1\,r\,n\,q$
$=$area $h\,5\,4\,q\,1\,d$.

Alternatively, by considering the isentropic expansion $4\,q$, the energy converted into work$=I_4-I_q$, which is represented by the area $p\,8\,4\,g$ and equals area $h\,5\,4\,q\,1\,d$.

From this analysis it is seen that the "intrinsic efficiency" is readily determinable for a multi-stage compressor with intercooling. The work input to such compressors must be measured by adding to the enthalpy gain of the air, the heat rejected to the coolant in the intercooler.

From the analysis which has been made of the compression process it is now clear that only the "intrinsic efficiency" gives full

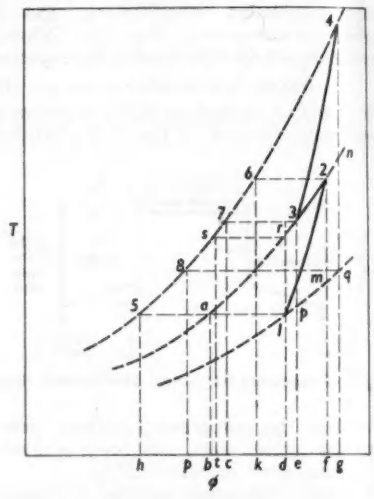


Fig. 8—Analysis of Two-Stage Compression with Partial Intercooling

credit to the compressor for its performance. The isentropic efficiency debits to the compressor the thermodynamic loss produced by aftercooling of the discharge air to the temperature which would have been attained by isentropic compression. The polytropic efficiency does not give credit to the compressor for the available portion of the energy transferred to the air by the irreversible portion of the compression. Though the polytropic efficiency measures the true compressor performance more closely than the isentropic efficiency, it is, however, a path function and, as is well known, the assumed polytropic path of constant index n does not represent the true state of the air passing through a flow compressor. In contrast, the "intrinsic efficiency" is independent of the "path" and recommends itself to engineers who view this process from a rational thermodynamic standpoint.

Symposium on Mix Design and Quality Control of Concrete.—A symposium on the design of concrete mixes and the quality control of concrete is being organised by the Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1, in conjunction with the Reinforced Concrete Association, the Joint Research Committee of the British Cast Concrete Federation, the Cast Stone and Concrete Federation, and the Prestressed Concrete Development Group. The Building Research Station and the Road Research Laboratory of the Department of Scientific and Industrial Research have agreed to co-operate. The symposium will take place at the Institution of Civil Engineers from April 6–8, 1954, and the Cement and Concrete Association states that full details of the programme will be issued as early as possible.

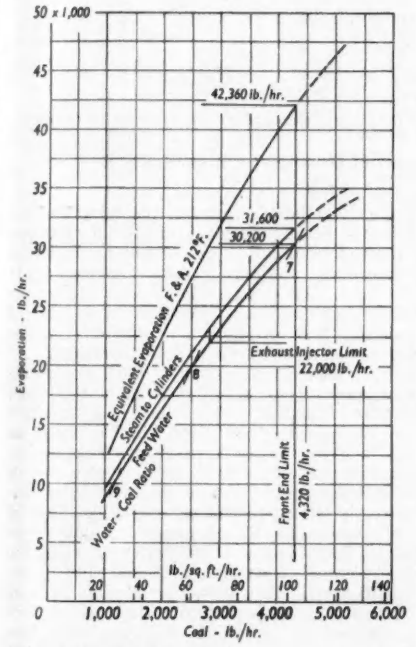
Performance and Efficiency Tests on the "Britannia" Locomotives

No. I

By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E.

Since the Railway Executive inaugurated the practice of publishing bulletins containing complete details of full-dress thermodynamic trials on modern locomotives, no test results have been awaited more keenly than those from the new British Standard "Pacifics" of the "Britannia" class. These details have now been published, and in this article and a succeeding one the author reviews the latest test bulletin and analyses some of the results.

THE testing procedure at constant rates of evaporation developed on the Great Western Railway at Swindon, and supplemented by the ingenious practice of controlled road testing, has, with several well-known classes of locomotives, revealed standards of sustained power output far beyond anything that was demanded from those locomotives in regular service. At Swindon, in particular, analysis of front-end conditions has led to the steaming capacity of certain engines being increased by spectacular amounts, especially in the case of the London Midland class "4" 2–6–0 as recorded in THE ENGINEER of June 13, 1952; with this engine the original maximum output of 9000 lb of steam per hour was increased to 17,000, an improvement of no less than 89 per cent. In view of these achievements the results from the "Britannia" locomotives are naturally of very great interest, since the opportunities were available to incorporate all the merits of existing designs which have been found to give advantageous results in modern conditions of work. The bulletin just published gives the performance of the new locomotives under ideal conditions. The two engines which were examined on the stationary testing plant at Rugby were both brand new at the time; they had been prepared for test during building at Crewe works and had run in traffic for no more than 560 miles and 1040 miles, respectively, before the first tests to which they were subjected. Engine No. 70005 ran 6890 miles at Rugby and about 5000 miles in controlled road testing conditions, while No. 70025 ran 6350 miles on Rugby plant alone.



South Kirkby coal, c.v. 13,800 B.Th.U. per pound; exhaust steam injector; evaporation.

Fig. 1—Boiler Performance

While the tests described in the bulletin are thus of exceptional interest as showing the optimum capacity of the locomotives a further bulletin, showing the performance in the most run-down condition in which such locomotives could be accepted for traffic, would be of equal or greater interest, since the design incorporates a number of details specifically intended to aid in the amassing of high mileages between periodical repairs, and to minimise the day-to-day maintenance necessary at running sheds. The thermodynamic performance in such conditions is an essential part of the picture without which it is not possible to make a true assessment of the all-round capacity of the "Britannia" locomotives. There is also the matter of fuel. In the preliminary notes to the tests results themselves the bulletin mentions two aspects of the large boiler fitted to these locomotives which are not brought out in the test results, but which are of value to the operating department, namely:—

(*a*) The ability of a larger grate to carry more clinker or ash from poor quality coal before the air supply through the fuel bed becomes sufficiently restricted to affect steaming adversely. This point, it is stated, will be brought out in the bulletin for the W.D. 2–8–0 and 2–10–0 locomotives shortly to be published.

(*b*) The larger reservoir capacity both in heat and steam which provides a reserve for short periods of heavy demand, such as acceleration up a grade after a check and to tide over temporarily adverse firing conditions.

It is very difficult to assimilate, under strictly controlled test conditions, the handicaps that can occur on an ordinary run from a "bad patch" with the fire. Yet these handicaps are generally far more trying to enginemen, and far more productive of lost time, than any increased fuel consumption due to run down mechanical condition, providing the locomotive in question will steam freely. In the recent tests carried out with the "Britannia" engines No. 70005 and No. 70025, the higher grade fuel used, a Hard South Yorkshire, was supplied in very large pieces; they were broken down to cobbles for firing and the resulting slack was screened out so that only pieces over 1in size were fired. While this achieved uniformity with the physical nature of the comparative Grade 2B Hard East Midlands coal used in the second series of tests described in the bulletin, this special preparation of the Grade 1A coal does emphasise the exceptionally favourable conditions in which the two locomotives were tested—conditions which are reflected in the boiler efficiencies. At 2000 lb of coal per hour these efficiencies were 80 per cent with the South Kirkby (Grade 1A) and 75 per cent with Blidworth (Grade 2B).

We can now pass to a discussion of the test results, set out in the admirably clear and concise way of previous bulletins in this series. Fig. 1 shows the performance of the boiler as recorded on the stationary testing plant with South Kirkby coal. The "front-end limit" is seen to be 31,600 lb of steam per hour from boiler to cylinders, and this required a consumption of 4320 lb of coal per hour. The corresponding diagram with Blidworth coal, having a calorific value of 12,600 B.Th.U. per lb, against the 13,800 B.Th.U. of South Kirkby, shows that the firing rate to achieve approximately the same maximum steam output was 5066 lb of coal per hour. The graphs of boiler efficiency are shown in Fig. 2, with the results for South Kirkby and for Blidworth coal on the same diagram. The firing rate necessary with the latter is rather higher than a proportionate allowance on the basis of relative heating values might suggest; but this is undoubtedly a measure of the lower grade of the coal itself, as a locomotive fuel, in addition to its lower calorific value.

The boiler and cylinder performances were established on the stationary test plant. With the "Britannia" locomotives indicating was carried out only on the test plant and for this purpose a modified form of "Farnboro'" electrical indicator was used. The application of this indicator to locomotive work was described in THE ENGINEER for October 20, 1950, in connection with the use of the L.M.S. mobile test plant. It will be recalled that this type of indicator produces diagrams on a basis of angle of rotation of the driving axle instead of the stroke basis hitherto most familiar, and also builds up the diagram over a larger number of revolutions instead of one or two. The diagram is composed of a number of dots produced by perforating a special paper with an electric spark, the position of the spark being determined on one axis by the angular position of the axle and, on the other, by the pressure of steam in the cylinder. This is done by picking up electrically the moment when the steam pressure balances a gas pressure which can be varied at will and which operates the spark pointer of the indicator.

The modifications to the original indicator, to make it more suitable for use on a steam locomotive, have been concerned with the pressure sensitive elements; these are now

Maximum Sustained Evaporation: Performance Related to Boiler Proportions: Blidworth Coal

Locomotive: Power class / Type	4 L.M. 2–6–0	4 Std. 4–6–0	5 W.R. "Hall"	7 "Britannia"
Total heating surface, square feet	1,452	1,709	2032·5	3,192
Grate area, square feet	23	26·7	27·07	42
Maximum sustained evaporation, lb per hour	17,000	19,600	21,690	31,410
Ratio: Evaporation/Total H.S.	11·7	11·5	10·7	9·85
Ratio: Evaporation/Grate area	740	735	802	748
I.h.p. at 60 m.p.h.	1,150	1,410	1,450	2,200
Cut-off, per cent	23	32	20	36
I.h.p. per square feet of grate area	50	52·8	53·5	52·5
I.h.p. per ton of engine weight	19·5	20·7	19·2	23·4
Nominal tractive effort per ton of engine weight, lb	408	372	360	342
Coal per i.h.p. hour, lb	2·5	2·3	2·5	2·3

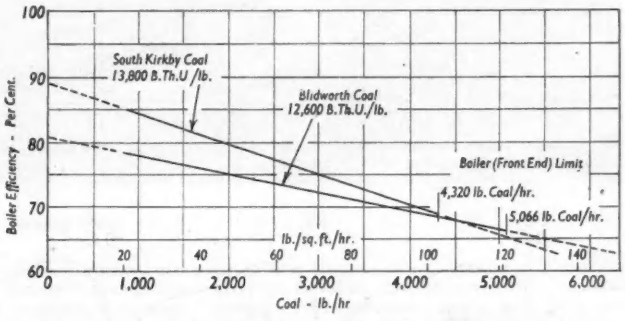
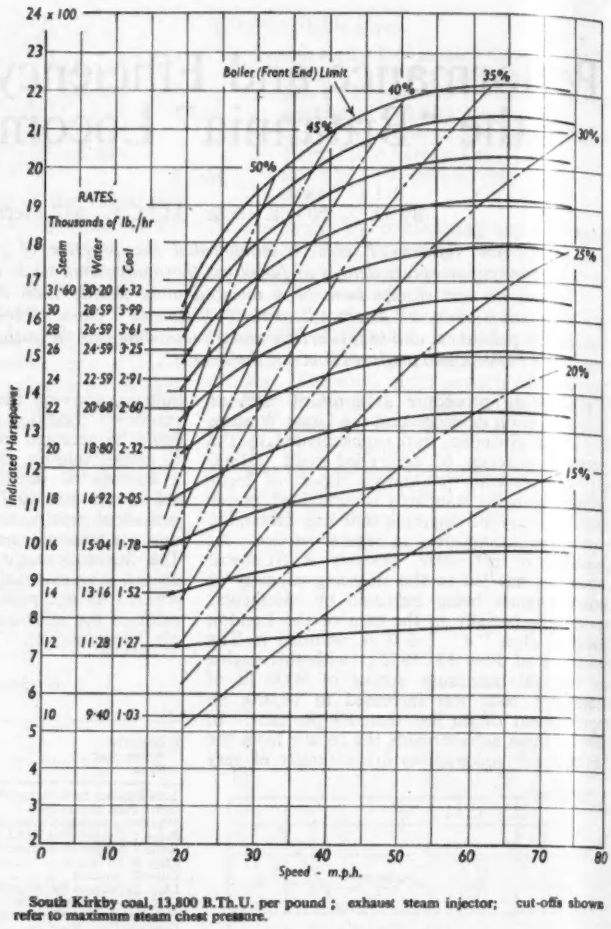


Fig. 2—Boiler Efficiency with Different Coals

suitable for use in contact with either saturated or superheated steam. The electrical system has also been altered to enable all four cylinder ends to be indicated simultaneously. This improvement has speeded up the process. In Fig. 3 examples of typical indicator diagrams are reproduced; the upper one illustrates what may be termed a normal express-passenger condition, when the locomotive was developing 1028 i.h.p., working in 15 per cent cut-off, at a speed of 69¼ m.p.h. The lower diagram shows heavy working at medium speed: 2006 i.h.p.; 45 per cent cut-off, 40¼ m.p.h. The form of the diagrams will be unfamiliar to the majority of readers, and while from the results published there can be no doubt about the efficiency of the cylinder performance of the "Britannia" locomotives, it would have been interesting to see one or two of these diagrams converted into normal stroke-basis diagrams so that comparison could be made with diagrams recorded with other types of locomotive. It would, for example, have been something of a novelty to see the form of the indicator diagram when developing 2200 i.h.p. at 62 m.p.h., with full regulator and 35 per cent cut-off. As will be seen later, such a performance was sustained, and at a coal consumption of 1·95 lb per indicated horsepower hour.

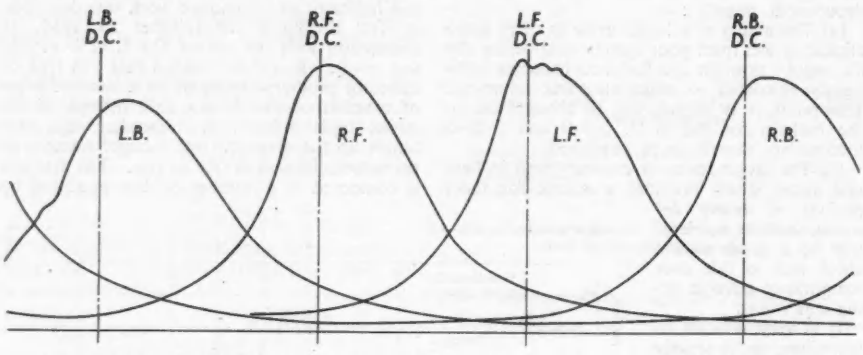
The full chart of indicated horsepower characteristics is shown in Fig. 4. This relates to firing with South Kirkby coal, but there is little difference between the characteristics with South Kirkby and Blidworth, since roughly the same boiler output was achieved with the lower grade fuel by heavier firing. Fig. 4 is certainly a chart of exceptional interest. Since the general adoption of long-lap, long-travel valves on British locomotives regular working with short cut-offs between 15 and 20 per cent have been favoured, in conjunction with a wide, if not necessarily full, regulator opening. Many of the best enginemen have come to look askance at running with as much as 25 per cent and full regulator on level road, and such a cut-off as 35 per cent, used continuously, would be regarded as nothing short of "thrashing" even if the boiler would stand it. But the test performances of the "Britannia" locomotives show that they can not merely "take it"—albeit with the services of two firemen—but take it efficiently. The coal consumption per indicated horsepower hour is at a minimum at a steam rate of about 18,000 lb per hour at 60 to 70 m.p.h.; the indicated horsepower is then about 1300 and the cut-off 22 per cent. From the excellent coal rate of 1·5 lb per indicated horsepower hour in these conditions the rate rises to no more than 1·95 lb in what may well be termed "flat-out" conditions; 2200 i.h.p., 60 to 70 m.p.h., and cut-off 32 to 35 per cent. The coal consumptions quoted are with South Kirkby; but while the rates themselves are very good the actual weights of coal to be fired in sustaining such an output are considered to be beyond the limit of one fireman on the "Britannia" engines. To sustain an output of 2200 i.h.p. at 60 m.p.h. the firing rate is 72 lb per train mile with South Kirkby coal and 84·5 lb with Blidworth.

In view of this fine performance recorded on the Rugby test plant it is naturally interesting to try and make comparisons with other locomotives. Many examples of high power output have been quoted from tests made in past years, either by indicating or with dynamometer cars. But none, in this country, at any rate, have been made in such comparably accurate and stabilised conditions as those of which details have been published recently by the Railway Executive.

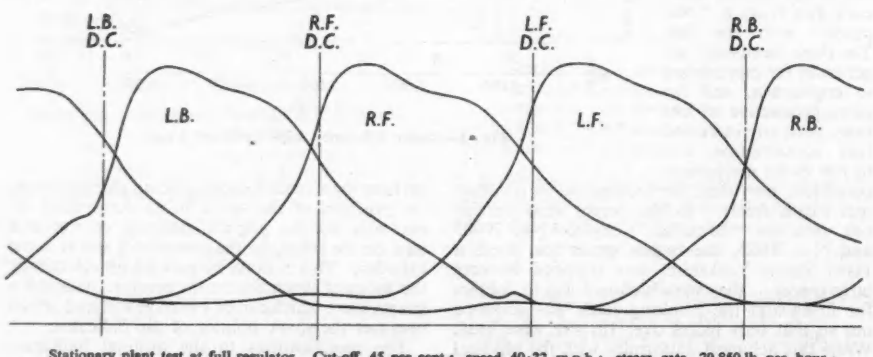


South Kirkby coal, 13,800 B.Th.U. per pound; exhaust steam injector; cut-offs shown refer to maximum steam chest pressure.

Fig. 4—Indicated Horsepower Characteristics



Stationary plant test at full regulator. Cut-off, 15 per cent; speed, 69·24 m.p.h.; steam rate, 15,210 lb per hour; i.h.p., 1028; indicator spring rate, 60 lb per inch.



Stationary plant test at full regulator. Cut-off, 45 per cent; speed 40·32 m.p.h.; steam rate, 29,850 lb per hour; i.h.p., 2006; indicator spring rate, 60 lb per inch.

Fig. 3—Typical Indicator Diagrams

From these latter, however, the table on page 103 has been prepared to show the maximum sustained evaporation in relation to the boiler proportions, and the indicated horsepower at 60 m.p.h. The results for all four engines are those obtained with Blidworth coal. For a group of four locomotives of dissimilar origins the results appear remarkably consistent. All four, however, are equipped with draughting arrangements in accordance with the latest Swindon practice. In cylinder arrangement the Western Region "Hall" differs from the rest in having inside Stephenson's link motion, whereas the other three engines have outside Walschaerts gear. When the indicated horsepower is related to engine weight the "Britannia" shows up to advantage, as one would expect from the size of the boiler in relation to the nominal tractive effort and the power classification. This point, in relation to work on the road in varying conditions will be discussed in a second article dealing more particularly with the controlled tests on these engines, on one of which an even higher rate of evaporation was attained.

(To be continued)

AGRICULTURAL MACHINERY FIRM'S PROGRESS.—A well-produced brochure, which has been issued by Rotary Hoes, Ltd., Horndon, Essex, to commemorate the Coronation of Her Majesty Queen Elizabeth II, records the story of the firm's development and progress. The principal product of the firm is the "Rotavator"—a rotary cultivator—of which there are now many versions, small and large. The original design of the implement came from Mr. Arthur Clifford Howard, an Australian engineer, who started the forerunner of the present business in the early 1920's. Mr. Howard came to England in 1938 and with Captain E. N. Griffith, the present chairman, established Rotary Hoes, Ltd. Now the company produces other implements in addition to the "Rotavator" and also tractors. In addition to the works at Horndon it has in recent months acquired a factory in the new town at Basildon, in Essex. An indication of the firm's rapid development in the post-war years is shown by the fact—pictorially presented in the brochure—that whilst in 1946 its employees numbered 400, by the end of last year the total was in the region of 1200.

Machining Plant for Turbine Casings

An interesting arrangement of horizontal milling, boring and drilling machines round a common work plate is in use at the Rugby works of the British Thomson-Houston Company, Ltd., for machining large turbine castings. With these machines and their ancillary equipment, all of which were supplied by Wm. Asquith, Ltd., it is stated that productivity is increased, floor space is saved, and work of a more varied character can be undertaken on the same set-up.

As a result of investigations into the methods used in the machining of turbine casings at the Rugby works of the British Thomson-Houston Company, Ltd., it was decided that productivity would be improved if milling were substituted for planing, and if the movements of work between operations were reduced. It was considered that the use of horizontal milling and boring machines, in conjunction with means for positioning the work piece accurately and easily, offered the best method of increasing the output from a limited floor space, as work of a more varied character could be undertaken at the same set-up. Moreover, the anticipated improvement in accuracy and quality of the finished work would prove an advantage particularly where the joint surfaces of high pressure steam casings were concerned.

As a result of these decisions a plant, which is now in operation, was ordered from Wm. Asquith, Ltd., of Halifax. This plant, which can be seen in the accompanying illustrations, consists essentially of a large work plate on three sides of which are arranged horizontal milling, boring and drilling machines of various capacities, equipped where necessary with rotating and traversing tables for carrying the workpieces being machined.

The floor plate is specially designed to withstand the heavy loads. The 15¾in deep work plate itself weighs some 150 tons, and is made in sixteen sections, accurately fitted and bolted together to form one area 53ft long and 34ft wide. Tee slots, machined from the solid in each section, are accurately matched across the width of the plate and are machined parallel to one another to form datum lines for setting purposes.

A special foundation for the plate, which was designed by the British Thomson-Houston Company, gives access to the solid packing pieces beneath and provides relatively easy means of adjusting the level of the work plate should there be any movement due to excessive weight or foundation settlement. A covered trench on the fourth side of the work plate gives access to the foundations for levelling purposes, and situated in this trench are various power points for supplying current to portable equipment which may, from time to time, be used on the floor plate. A trough in the foundation around the plate collects spent cutting coolant which is drained away through channels to a trough whence it is pumped to the tools.

The principal machine is an Asquith duplex "NHB 1" horizontal drilling, boring and milling machine, which actually comprises two identical machines fitted to one common bed, and is set adjacent to and parallel to the 53ft side of the floor plate opposite the foundation access trench. This machine is thus at right angles to the tee slots in the floor plate. The machines themselves are of the standard horizontal floor design, but have a number of special characteristics for the kind of work for which they are required.

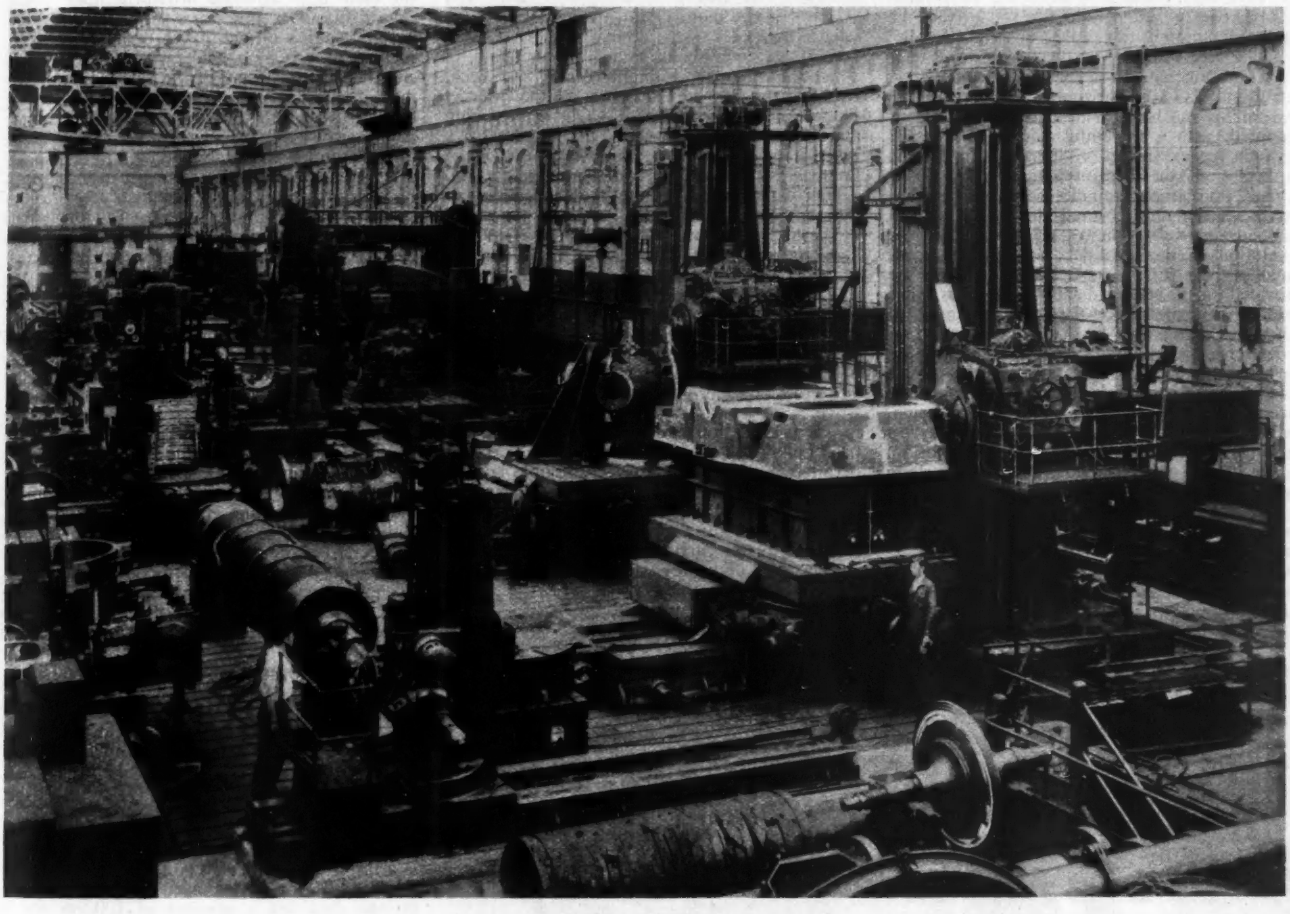
The 8in diameter spindle of each machine is driven by a 40-h.p. motor and has twenty-seven changes of speed from 1·2 to 125 r.p.m. Eighteen milling feeds are provided for the slide and range from 0·52in to 24in per minute. Nine boring feeds, available at all speeds of the spindle, range from 0·008in to 1in per revolution of the spindle. In addition, nine changes are available at each relative speed of the gear range which is used, giving an overall feed range of 0·01in to 3·125in per spindle revolution. Separate motors are fitted for quick power traverse to the slide, column and the spindle.

The vertical traverse of the slides on the columns is 15ft, and in order to give the rigidity required when heavy milling operations are being performed with the spindle at the top limit, the bed is made of a special width of 9ft. On the front face of each column there is provided a facing having machined tee slots so that special attachments may be bolted to the column when required. Each column is fitted with rules and verniers for the column, slide and spindle traverses; optical systems enable the operator to view the verniers from the operating platform on the slide. The optical equipment consists of a large range magnifying glass for the slide traverse, a vertically-mounted telescope for the column traverse, and a combined periscope and telescope for the spindle traverse.

The operator has full control of a machine from the operating platform, and a remote pendant control push-button box is also provided.

The bed of the duplex machine is 62ft long and permits a maximum setting distance of 49ft 7½in between the spindles of the two columns. To prevent the columns over-running the ends of the bed or fouling each other when traversing, electrical tripping devices are fitted.

The machines can be used either for boring or milling operations and several special milling attachments are provided. One of these attachments is a swivel milling head which can be



Horizontal Boring and Milling Plant

moved in two planes around a ram and it is bolted to the front facing of the spindle slide of the machine, the drive to the milling head being taken from the spindle itself. A further attachment is a snout support for the spindle which gives it an extra bearing when milling away from the faceplate. In the photographs we reproduce below, the left-hand machine is shown being used for milling vertical faces and the right-hand machine with the angle face milling attachment set up for milling horizontal faces.

Situated on the second side of the floor plate, at right angles to the duplex machine and parallel to the tee slots in the floor plate, is an Asquith "HRG" horizontal boring and milling machine. This machine has a spindle diameter of 4in, the vertical traverse of its slide being 7ft, and the horizontal traverse of the column 28ft. A swivelling motion allows the column to be rotated by hand through a full circle. The machine has twenty-one spindle speeds ranging from 6·7 to 740 r.p.m., nine boring feeds from 0·005in to 0·051in per revolution of the spindle and nine milling feeds from 0·39in to 4in per minute. Its spindle is driven by a 10 h.p. motor and the slide and column quick traverse motions by 3 h.p. motors.

Electrical tripping devices, fitted to the horizontal traverse motions, ensure that the column will not overrun the end of the bed or foul the adjacent column of the duplex machine.

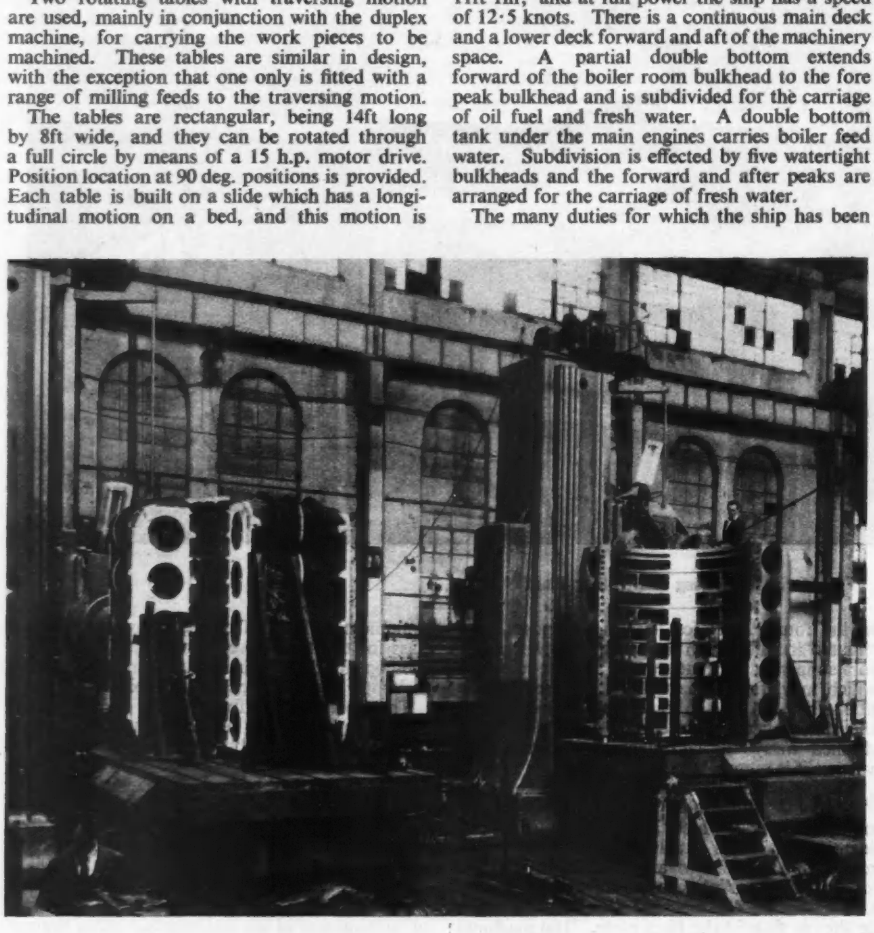
At the opposite side of the floor plate to the "HRG" machine, and parallel to it, is an Asquith "RG 1" horizontal drilling, boring and milling machine. This machine also is floor mounted, with a swivelling column, and it has a 3ft 6in vertical traverse to the slide, the column being mounted on a bed 20ft long.

The 2¼in diameter spindle of this machine has twelve speed changes from 21 to 750 r.p.m., and nine boring feeds from 0·0055in to 0·05in per revolution of the spindle. Nine milling feeds ranging from 0·66in to 6·2in per minute are provided for the slide and column traverses. The main driving motor for the spindle is rated at 5 h.p.

Two rotating tables with traversing motion are used, mainly in conjunction with the duplex machine, for carrying the work pieces to be machined. These tables are similar in design, with the exception that one only is fitted with a range of milling feeds to the traversing motion.

The tables are rectangular, being 14ft long by 8ft wide, and they can be rotated through a full circle by means of a 15 h.p. motor drive. Position location at 90 deg. positions is provided. Each table is built on a slide which has a longitudinal motion on a bed, and this motion is powered by a 20 h.p. motor. The feed motion on one table is provided by a separate 5 h.p. motor, and can be controlled from the operating platform of the appropriate column of the duplex machine by means of a remote push-button control box with a trailing cable. Each of the tables weighs 40 tons and has a maximum carrying capacity of 60 tons and they are shown in the photographs we reproduce.

A heavy Asquith "X.D.1" radial drilling machine included in the equipment has an 8ft radial arm and is mounted on a bed to give 16ft 6in of traverse. This machine is capable of drilling holes up to 4in diameter from the solid in steel, and it is placed adjacent to the work-plate. Other equipment provided includes a number of separate portable box work tables of two sizes, 72in by 36in by 48in and 36in by 36in by 48in. They can be used either separately or in combination to provide mountings on which components can be accurately positioned on the work plate for machining.



Face Milling on Large Machines

Twin-Screw Steamship "Vigilant"

The Mersey Docks and Harbour Board has added to its fleet the T.S.S. "Vigilant," a twin-screw vessel driven by two sets of triple-expansion engines of 1450 i.h.p. The ship, which has a length between perpendiculars of 160ft by 35ft beam, is equipped to carry out buoyage work and perform salvage, survey and fire-fighting services in Liverpool Bay.

At the Woolston shipyard of John I. Thornycroft and Co., Ltd., there has been completed recently the T.S.S. "Vigilant," a twin-screw steam buoyage, salvage, survey and fire-fighting vessel for service with the Mersey Docks and Harbour Board in Liverpool Bay. The vessel has been built to Lloyd's highest class for salvage purposes to the design of the Liverpool consultants, Graham and Woolnough, in collaboration with Captain W. R. Colbeck, R.N.R., the marine surveyor of the Mersey Docks and Harbour Board. Our photograph, reproduced on page 107, shows that the ship has a raked stem, cruiser stern, two masts, of which the foremast is fitted with heavy lifting derricks, and a boat extending from about midships almost to the stern.

The hull form was decided upon after models had been run in the Thornycroft tank, and the principal dimensions are: length overall, 172ft 6in; length between perpendiculars, 160ft; breadth moulded, 35ft; depth moulded to main deck, 16ft 6in; mean load draught, 11ft 1in; and at full power the ship has a speed of 12·5 knots. There is a continuous main deck and a lower deck forward and aft of the machinery space. A partial double bottom extends forward of the boiler room bulkhead to the fore peak bulkhead and is subdivided for the carriage of oil fuel and fresh water. A double bottom tank under the main engines carries boiler feed water. Subdivision is effected by five watertight bulkheads and the forward and after peaks are arranged for the carriage of fresh water.

The many duties for which the ship has been designed have called for the provision of a large amount of accommodation to house the ship's officers and crew, surveyors, wreck party and salvage engineers. Ship's officers and engineers have their cabins in the aft end of the house on the main deck arranged around a small dining saloon on the centre line, while the crew are accommodated on the lower deck aft. Access to this space is by a ladder way down from an entrance at the aft end of the deck house on the main deck and there is a large mess space, forward of which are seven two-berth cabins. A door to starboard in the deck house opens directly on to the accommodation for the six salvage engineers on the main deck, and a door on the port side of the house gives access to the accommodation for the wreck party of eleven, which is on the lower deck forward and consists of a large open space fitted with two-tier berths, a dining space, pantry, and a cabin for two divers. A comfortable saloon and pantry are situated at the forward end of the house on the boat deck and in this house are the cabins of the marine surveyor and his two assistants. A stairway from the vestibule leads up to the plotting room which is immediately abaft the wheel house on the navigating bridge. In the plotting room, which has large windows to give an extensive view, is a large plotting table, and the wheel house is fitted with two Kent clear view screens. The navigating equipment includes a Kelvin and Hughes echo sounder and radio and radar equipment supplied by the Marconi International Marine Communication Company, Ltd. The accomodation is heated by hot water radiators and mechanically ventilated, and there are two coal-fired galleys at the aft end of the main deck with a coal bunker arranged below.

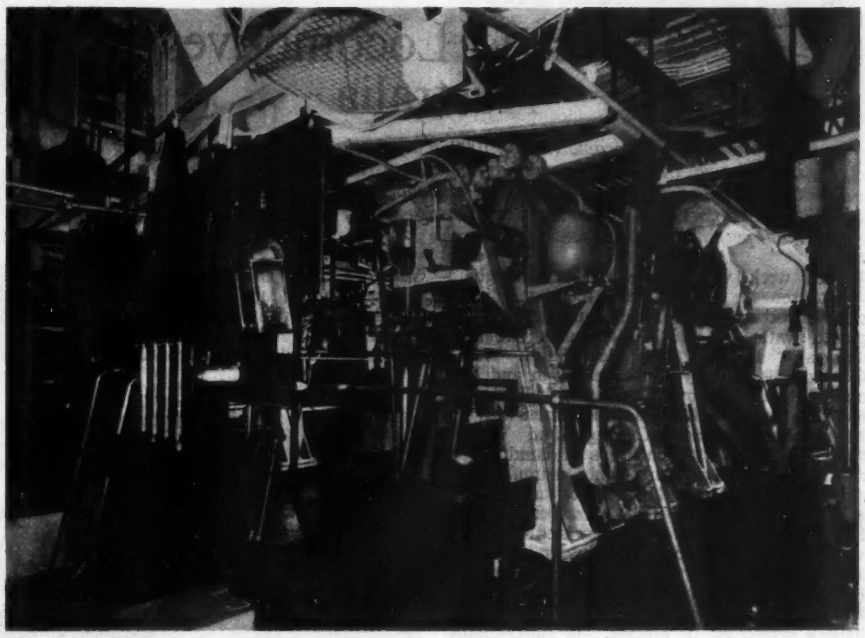
A hatch measuring 14ft 8in by 8ft and fitted with 3in wood covers and three tarpaulins is on the main deck forward and gives access to the forward 'tween decks and hold. In the 'tween decks are stores and shelves and in the hold is stowage space for fire fighting and salvage gear. The main deck forward is the main working space, and opposite the hatch there are sections of portable bulwark, to port and starboard, mounted on cast steel hinges, while at the bow is a heavy cast steel fairlead capable of taking a load of 100 tons. Arranged at suitable points on the deck are a number of 100-ton single bollards, each surmounted by an 18in diameter roller, and other associated deck castings, including samson posts, fairleads, eyeplates and cruciform bollards to deal with heavy salvage operations. Also arranged to line up with the bow casting is an anchorage to take a 100-ton purchase. Well forward is the tubular steel foremast, which is stepped on the lower deck and is slightly to port of the centre line, and is equipped with two heavy tubular derricks, the forward derrick being arranged with purchases for 5-ton and 10-ton lifts and the aft derrick with separate purchases to take 5-ton, 12-ton and 15-ton lifts. The power for the various operations is supplied by a 20-ton steam winch mounted immediately forward of the deck house and two 10-ton electric capstans, one to port and the other to starboard, with driving motors arranged on the lower deck. Forward to port is a 5-ton warping and cable capstan, for working the single anchor,

having the electric driving motor on the lower deck, and aft is fitted a 4-ton warping capstan with its driving motor slung under the deck. All the deck machinery has been supplied by Clarke, Chapman and Co., Ltd. Steering is effected by a combined hand and two-ram electro-hydraulic gear, manufactured by Brown Brothers, Ltd., acting directly on the crosshead of a semi-balanced rudder.

At the forward end of the deck house on the main deck is a control room containing the control switchboard, and from this room a trunked hatch leads down to the generator room, which is on the tank top immediately forward of the main machinery space. Diesel oil tanks and oil fuel settling tanks are arranged to port and starboard at the forward end of the room, which contains the generators, fire and salvage pump, air compressors and exhausters, and boiler fuel and diesel oil transfer pumps.

The electric power for the auxiliary and deck machinery is supplied by two diesel-driven generators, the driving unit consisting of a Davey, Paxman twelve-cylinder vee engine with one bank of cylinders blanked off, rated to develop 225 b.h.p. at 1160 r.p.m., and arranged for 24V battery electric starting and mounted on a fabricated steel underbase. Each engine is flexibly coupled to an Allen two-bearing, open pattern d.c. generator capable of a continuous output of 180kW at 1160 r.p.m. and 150kW at 1000 r.p.m. These machines are arranged to operate in parallel and to give a maximum of 350V for driving the fire pump at its maximum loading, and connections are made at the switchboard so that the machines are self-excited when supplying power for deck machinery at 220V and separately excited when operating at 110V. For ship's lighting there is an Allen generator, having a full-load output of 35kW at 220V d.c. at 900 r.p.m., driven by a Mk. 4 R.W.Z. Ruston Paxman diesel engine rated to develop 60 b.h.p. at 900 r.p.m. There is, in addition, an Allen steam-driven generator, which is rated at 35kW at 550 r.p.m. and is driven by a steam engine having cylinders of 6in and 10½in diameter by 4½in stroke, taking steam at 180 lb per square inch. This generator is not in the generator room, but is installed at main deck level in the engine-room entrance, where there is also installed a diver's air compressor driven by a Reeder steam engine.

The Drysdale fire and salvage pump, which can deliver 440 tons of sea water per hour at a pressure of 230 lb per square inch at the base of the monitors, is driven by an Allen electric motor of 435 b.h.p. at 2100 r.p.m. There is a 10in diameter rising main, which supplies water to the two monitors, one mounted on the top of the plotting office and the other mounted on top of the deck house, containing stores, at the after end of the boat deck, and to a number of rail guns arranged at intervals on the bulwark around the main deck. For the fire protection of the ship sprinklers are fitted to both masts and the funnel. There are two rotary air compressors and exhausters, arranged to run separately or in tandem, each driven by an electric motor of 65 b.h.p. at 980 r.p.m. Lifesaving arrangements include one double-ended lifeboat powered by a 20 h.p. Thornycroft diesel engine and a square stern diving boat, both having a capacity of forty-two persons and both carried in Welin-Maclachlan gravity davits, each set being operated by winches.

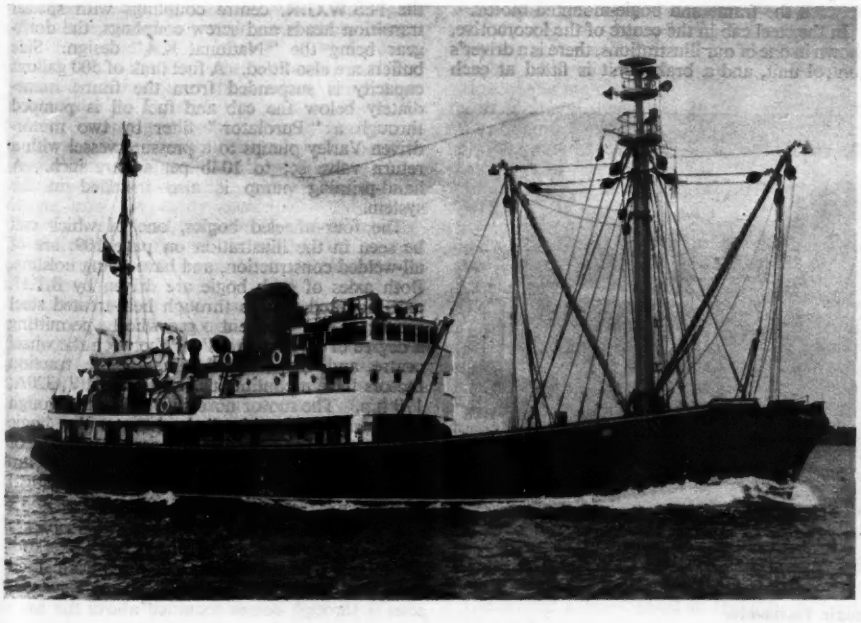


Engine Room Looking Aft

Main Machinery

The ship is propelled by two sets of triple-expansion engines, constructed by the shipbuilders, capable of developing a total of 1450 i.h.p. at full power and 1300 i.h.p. for continuous service when supplied with saturated steam at 220 lb per square inch pressure. The engines have cylinders of 11½in by 19in by 32in diameter by 21in stroke, and drive four-bladed manganese-bronze propellers having a diameter of 7ft 9in and a pitch of 7ft 8in through Michell thrust blocks and bearings. All the engine-room auxiliaries are driven independently of the main engines and include two steam-driven air pumps, a pair of feed pumps supplied by G. and J. Weir, Ltd., a steam-driven Drysdale circulating pump, and a Carruthers steam-driven duplex bilge pump. Other pumps, such as the general service, fresh water and domestic fresh water, are mainly electrically driven and of Drysdale manufacture. There are four calorifiers and associated circulating pumps arranged to port and starboard, two forward and two aft of the machinery space, and one regenerative condenser.

Steam is supplied from two oil-fired, forced draught, single-ended, two-furnace Scotch cylindrical marine return-tube boilers associated with one exhaust feed water heater, a pressure feed filter and feed filter hotwell tank. A Wallsend oil fuel pumping and heating installation is fitted and for lighting up the boilers from cold a motor-driven oil fuel pump and auxiliary heater is supplied. At the aft end of the tunnel recess a Westmoor horizontal sliding watertight door, mechanically operated, gives access to workshop and engineers' store.



Twin-Screw Steamship "Vigilant"

Road Vehicle Factory Extension

The extensions to the Fallings Park works of Guy Motors, Ltd., Wolverhampton, have now been completed. The primary object of the extension is to enable the production of Sunbeam trolleybuses to be undertaken on this site, to which have been transferred most of the machine tools from the original factory of the Sunbeam Trolleybus Company.

An extension to the existing machine shop has been made, giving an increase of some 17,000 square feet. The construction of this building was similar to that of the existing machine shop and the floor levels were arranged to coincide, so that when the dividing wall was demolished the new area became part of the whole machine shop, now covering some 60,000 square feet.

Many hundreds of tons of the more modern machine tools were moved from the Sunbeam works, and new ones were added and whilst the majority were installed in the new extension the whole of the machine shop was replanned to form a comprehensive unit.

In addition to the machine shop extension, new buildings covering an area of 18,000 square feet were erected to accommodate certain assembly departments, thus providing space for the Sunbeam assembly department within the original Guy buildings. Certain other sections of the factory were reorganised to improve facilities and at the same time achieve economy of floor space.

Diesel-Electric Locomotives for Australia

Ten diesel-electric locomotives of 1000 h.p., specially designed for shunting and heavy freight train haulage, are now under construction in this country for the New South Wales Government Railways. These locomotives are designed for a starting tractive effort of 51,000 lb and a continuous effort of 22,800 lb. They have a maximum permissible road speed of 57 m.p.h.

LAST week, we were invited to Birmingham to see the first of ten 1000 h.p. diesel-electric locomotives completed under an order placed with the British Thomson Houston Company, Ltd., by the New South Wales Government Railways. In the design and lay-out of these locomotives, the British Thomson Houston Company, Ltd., has collaborated with the Metropolitan-Cammell Carriage and Wagon Company, Ltd., in which firm's Midland works the mechanical parts are being manufactured and the completed locomotives are being assembled and tested. The diesel engines are being supplied by Davey Paxman and Co., Ltd.

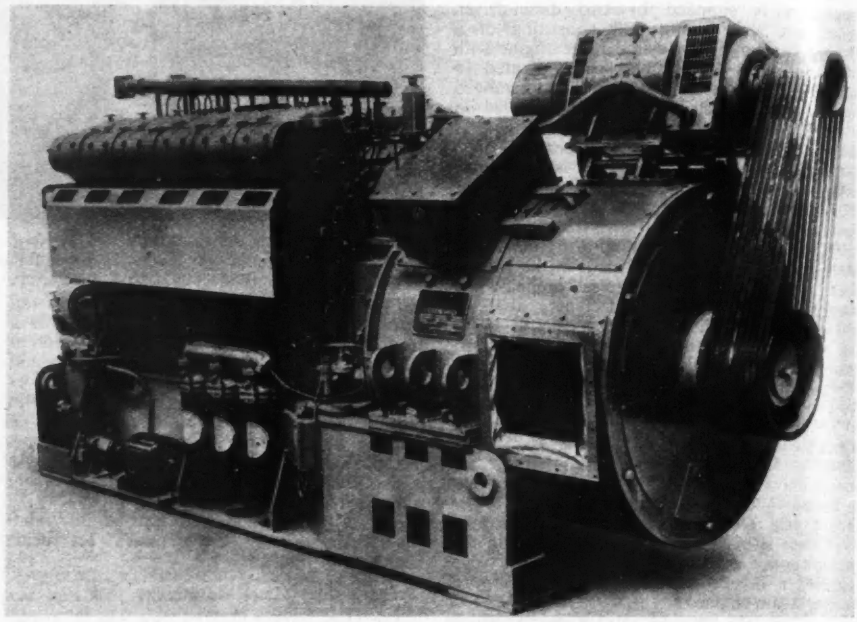
As can be seen from the photograph reproduced on this page, the locomotives are of the B_o–B_o type, and they are 43ft long between headstocks. The bogies are at 25ft centres and have a wheelbase of 8ft 9in. In full running order each locomotive weighs 80 tons.

These locomotives are particularly intended for shunting and hauling heavy freight trains and have a maximum tractive effort of 51,000 lb at starting, 22,800 lb continuously and 29,000 lb at the one hour rating. With a maximum permissible road speed of 57 m.p.h., the locomotives can be used for hauling passenger and mixed traffic trains. As two separate 500 h.p. engine-generator sets are fitted, at times of light running only one set need be used to give economy in operating. The driving cab is arranged centrally and dual controls are provided to enable the driver to operate from either side of the cab.

Each complete engine-generator set is mounted on a common bed, which is supported on the main frame through pads and resilient mountings. End stops are welded to the floor plate at each corner of the bed plate to resist displacement.

The whole of the power unit is enclosed within a sheet metal housing having sides comprising hinged doors which can be lifted off when required, leaving the skeleton structure to give free access for maintenance. A large section of the roof is removable to enable a complete engine-generator set to be lifted out, and alternatively a portion immediately above the engine cylinders can be removed for overhauling the engine in position. A further section is also removable for changing the compressor at one end, or alternatively for attention to the control frame at the other end adjacent to the cab.

The engine air intakes draw air through the roof and the air, after passing through horizontal Visco air filters, is ducted through flexible connections to the manifolds. The filters can be withdrawn through the sides of the roof and are accessible from the side walkways of the locomotive. Special silencers to the railway authority's requirements are mounted under the centre portion of the roof with flexible connections to the engine exhaust manifolds.



Engine Generator Set

Under each bonnet there are two electrically-driven motor blowers, each blower providing air for forced ventilation of the adjacent traction motor through ducting forming part of the main frame structure and a flexible connection between the frame and bogie-mounted motor.

In the steel cab in the centre of the locomotive, shown in one of our illustrations, there is a driver's control unit, and a brake unit is fitted at each operating position at diagonal corners of the cab. An adjustable upholstered revolving seat with back rest is provided at each driver's position, and fixed driving windows at both ends of the cab have electrically-operated windscreen wipers. Air-operated sanding and whistle valves are also fitted near the driving controls.

The cab floor is raised above the general level of the frame to improve the driver's look-out and at the same time to provide accommodation for brake and control units, &c., which are accessible through trap doors.

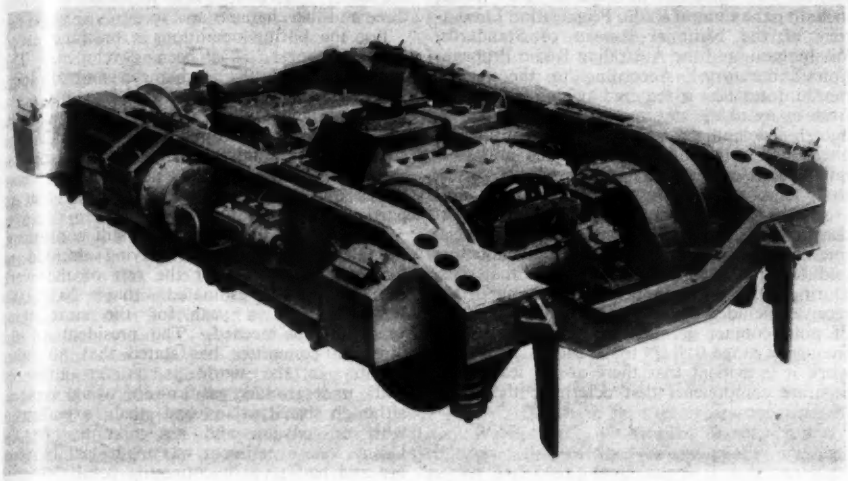
Access to the cab and to either side of the engine housings is by chequered plate walkways, along the sides of which are handrails. A shunter's platform at each end of the locomotive is guarded by a handrail and access from rail is by cut-in steps at each corner. Situated near the cab and forming part of each walkway there is a battery box in which is housed part of the Exide lead acid starting battery.

The main locomotive frame is an all-welded structure comprising rolled steel sections, plates, and fabricated units covered by a steel floor plate provided with trays to allow surplus oil to drain through pipes clear of the equipment below the frame. The frame is designed to accommodate the N.S.W.G.R. centre couplings with special transition heads and screw couplings, the draft-gear being the "National K 4" design. Side buffers are also fitted. A fuel tank of 500 gallons capacity is suspended from the frame immediately below the cab and fuel oil is pumped through a "Purolator" filter by two motor-driven Varley pumps to a pressure vessel with a return valve set to 10 lb per square inch. A hand-priming pump is also installed in the system.

The four-wheeled bogies, one of which can be seen in the illustration on page 109, are of all-welded construction, and have swing bolsters. Both axles of each bogie are driven by B.T.H. axle-mounted motors through heat-treated steel gearing, the resilient gearwheel permitting a degree of torsional resilience between the wheel centre and the toothed rim. These traction motors have a continuous rating of 450V, 320A, 170 h.p. The motor nose suspension is through links and "Silentbloc" bushes to the bogie crossbars. The motors are series wound, of conventional box frame construction, and are forced ventilated by motor-driven centrifugal blowers.

The wheels have solid centres with separate tyres, and the axles are arranged for "Skefko" self-aligning roller bearing axleboxes each fitted with one double-row bearing. The side suspension is through beams mounted above the axle-

1000 H.P. Diesel-Electric Locomotive



Bogie for Diesel-Electric Locomotive

boxes connected to auxiliary coil springs at the outer ends, with the inner ends of both beams on each side connected through links to one long laminated spring secured centrally below the bogie side frame. The swing bolsters are fitted with triple coil springs.

Cast steel centre pivots and side bearers are fitted and these, together with the bolster suspension pins, are lubricated through grease nipples mounted on each side of the bogie or underframe. Brass liners are fitted in the centre pivots.

The locomotives are fitted with Paxman 12RPHL Series II engines of 500 h.p. and running at 1250 r.p.m. These engines are normally aspirated and work at a b.m.e.p. of 88·5 lb per square inch. Twelve cylinders, arranged in vee-form, are of 7in bore by 7¾in stroke giving a maximum piston speed of 1615ft per minute. The crankcase is a single casting carrying an underslung crankshaft, the main bearings of which are located against side thrust by deep fitting faces. In addition to the usual main bearing retaining studs, the housings are further secured by transverse tie rods passing horizontally through them to the outside of the crankcase. Lightweight steel plate doors are provided on the crankcase through which the pistons and connecting-rods are easily removed.

Cylinder blocks of close-grained cast iron each carry three bores fitted with dry liners, all the cylinder blocks of an engine being identical and interchangeable. Single unit cylinder heads each carry the inlet and exhaust valves, the seats of which are well cooled to reduce the need for attention. Force lubricated valve rocker gear is totally-enclosed in readily removable covers. The fuel pumps, of C.A.V. "Monobloc" design, each contain six elements, and are mounted on the top of the cambox, being gear-driven from the camshaft.

Each engine is provided with a gear boost pump to ensure a supply of fuel under positive pressure to the injection pump galleries. The injectors are of single hole pintle spring-loaded design, and are easily accessible. Possibility of contamination of lubricant by fuel oil leakage is eliminated as the whole of the fuel system equipment is located outside the working parts of the engine.

A centrifugal hydraulic servo governor, fitted to the engines, is driven by bevel gearing from the end of the camshaft, engine lubricating oil pressure being used as the medium to operate the fuel pump control. By this means a small and compact governor of great sensitivity gives full control over the speed range of the engine. The governor is so designed that in the event of the failure of the lubricating oil pressure, the engine is shut down automatically.

Forced lubrication is provided throughout by engine-driven pumps placed in the sump. The main pressure gear pump is driven from the crankshaft and feeds lubricant to the engine via triple full-flow filters arranged in parallel and protected by a safety valve normally adjusted to 80 lb per square inch. The oil leaving the filters enters the main oil gallery via a pressure relief valve which controls engine oil pressure at approximately 50 lb per square inch. A second pump in the sump, of the same design as the main pressure pump, is employed to pass oil at low pressure through the oil sections of the radiator for cooling purposes.

The Serck radiators are mounted at the outer ends of the locomotive, with the fan belt driven direct from the engine crankshaft, and a centrifugal circulating water pump is gear-driven from the free end of the engine.

The B.T.H. main generator is a single-bearing machine having a self-aligning roller bearing at the commutator end; the other end of the armature being solidly coupled to the engine crankshaft. It has a continuous rating of 650V, 500A, 325kW. The fabricated steel magnet frame combines strength with light weight and it carries supports on which are mounted an auxiliary generator and overhung exciter, which are driven by vee-belts from a pulley mounted on an extension of the main generator shaft. Insulation is class "B" throughout, consisting entirely of mica, glass and asbestos finally treated with a high-temperature insulating varnish. Air for ventilation of the main generators is drawn through filters mounted vertically in the bonnet side, access for cleaning being through louvred hinged doors. The air, after passing through the generators, is blown into the main compartment.

At each of the driver's positions in the cab is a control unit comprising power controller, key-operated reverse drum and instrument panel. The reverser key is removable in the "off" position only and must be inserted in the control unit which is to be used to drive the locomotive. In addition to the forward, reverse and off positions, the reverser key has an engine only position, which enables the engine to be run up and the control tested without actually applying power to the motors.

The reverser key and power handle are mechanically interlocked so that the power handle can only be operated when the reverser key is in either the forward or reverse position and the reverser key can be moved only when the power handle has been returned to the off position.

The engine control panel in the cab contains the starting switches, meters and gauges associated with the two engines. To start up an engine, the main generator is motored from the battery, suitable interlocking being provided to ensure that only one engine can be started up at a time, thus avoiding overloading the battery.

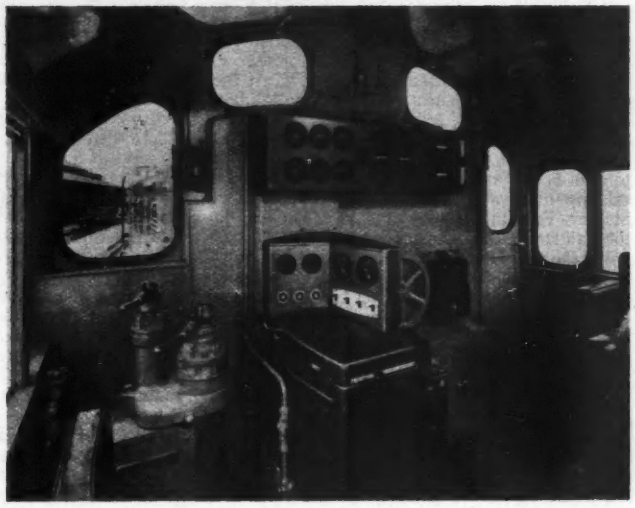
The control equipment, which is duplicated for the two separate engine-generator sets, is mounted in a framework under one bonnet. It comprises the necessary electro-magnetic contactors, the air-operated reversing switch, field diverter resistors and various relays. Warning lamps are used to show if any one of the motor blowers stop, if the oil pressure in an engine is low, or if the cooling water temperature is too high. It is left to the driver to take such action as may be necessary to overcome the particular fault.

The control scheme is based on the use of the familiar three-winding generator, which has a differential series winding, a self-excited winding and a field winding supplied from a speed-sensitive exciter. With this arrangement a very small drop in engine speed is sufficient to reduce the load to a point where engine power and generator output are balanced.

The locomotives are provided with couplers to permit multiple unit operation with control by one driver. When the engines have been started up in their respective locomotives subsequent control can be taken over at any one of the operating positions. As it is intended always to have a second man in the locomotive cab, no "dead-man's" handle is provided.

A "Tonum 'E'" headlight is fitted at each end of the locomotives and also two of the railway company's standard marker lamps.

Australian Westinghouse "A-7-EL" braking equipment is fitted, the parts being supplied jointly by the Westinghouse Brake Company in England and the Westinghouse Brake Australasia Proprietary, Ltd. This brake equipment is arranged for multiple working and the driver's stand incorporates two brake valves, one automatic and one independent, the former for multiple operation and for operation of the automatic brakes throughout the train and the latter for independent operation of the locomotive brake for shunting, &c. Each locomotive is fitted with four 12in by 8in brake cylinders and automatic slack adjusters, all bogie mounted. Clasp brakes are provided on all wheels, and the brakes are operated through levers and pull rods by air cylinders and slack adjusters, one of each of which is mounted direct on the outside of each bogie side frame.



Interior of Driver's Cab

OVERDRIVE GEAR.—It has been announced by Morris Commercial Cars, Ltd., that an overdrive system is to be incorporated as standard and without extra cost on its range of vehicles. It is stated that a reduction of 20 per cent in engine speed is obtained with the gear engaged, which leads to an approximate fuel saving of 10 per cent.

Radio Research in 1952

A REPORT entitled "Radio Research, 1952," covering the work of the Radio Research Board and the Director of Radio Research, was published last week by H.M. Stationery Office (price 2s.) for the Department of Scientific and Industrial Research. The report outlines the work done during 1952 at the Radio Research Station, Slough, at the overseas recording stations maintained by Slough and at the British Universities collaborating with the D.S.I.R. It may be mentioned in passing, that the bulk of the research programme is concerned with wave propagation and that most of the work involves fundamental studies which are of importance in the efficient operation of radio communication systems.

In a section of the report dealing with ionospheric research, it is recorded that two new ionospheric observatories were brought into use during the year, one at Khartoum and the other at Port Lockroy in the Falkland Island Dependencies, so that there are now seven observatories established under the auspices of the department in this country and overseas for the study of the properties of the ionosphere, while other countries maintain another sixty observatories.

As mentioned in the report, a direct method of examining the behaviour of the ionosphere at oblique-incidence is being developed. Signals propagated by way of the ionosphere and reflected back to the transmitting point from regions on the earth's surface up to several thousand kilometres distant are picked up and measured. The skip distances observed in this way have been found to agree with calculated values obtained from vertical-incidence observatories immediately below the reflecting point in the ionosphere. It is thought that the new technique can be used to study propagation conditions at a distance and so supplement the information obtained from the sparsely distributed observatories which keep watch on the behaviour of the ionosphere immediately above them.

The effects of solar eclipses on radio communications form the subject of one section of the report, which records the visit of two expeditions to Africa for the February eclipse. There, one party made observations at Khartoum, where the eclipse was total, and the other at Ibadan, Nigeria, where the eclipse was 75 per cent. The report gives the result of these observations and refers to the August eclipse which was total in South America and was studied from the existing observatories of the D.S.I.R. at Port Stanley, Falkland Islands, and Port Lockroy in the Falkland Island Dependencies.

In the study of the propagation of low-frequency waves along the ground (the report states) phase measurements over land paths were continued during the year on a frequency of 127·5 kc/s, using transmissions from stations of the Decca navigator system. This form of propagation depends on ground conductivity and, therefore, on geological structure and the report points out that the results obtained generally confirm the theoretical expectations based on a knowledge of the ground structure and the associated electrical properties.

On the experience gained, a new method of measurement is being developed to study the important practical case of transmission across a coast line, and an outline of the method is given in the report. Briefly, a radio link operating at about 800 Mc/s is used to provide a reference phase at the mobile measuring station. This u.h.f. signal is pulse-modulated at a frequency corresponding to a sub-multiple of that of the l.f. transmitter concerned and is radiated along the chosen path from a point close to that transmitter. The phase of the l.f. signal relative to that of the u.h.f. modulation is measured. Thus, since the speed of propagation of the u.h.f. signal (which is independent of the ground) is known to sufficient accuracy, the phase changes and speed of the l.f. wave can be deduced. The report states that preliminary trial measurements have been made over short land paths.

Among the special reviews of progress recorded in the report is one dealing with atmospheric noise at high frequencies, from 2·5 to 20 Mc/s. It is pointed out that this work is based on analyses of observations made regularly at a number of stations throughout the world, including the Central Radio Propagation Laboratory of the National Bureau of Standards, Washington, and the Australian Radio Propagation Laboratory. According to the report, more information is required at high frequencies from many of the stations, particularly for daylight hours, and the survey is being continued; additional stations are contemplated and it is intended to extend the frequency range down to 15 kc/s.

Another special survey included in the report deals with research on materials of special interest for radio applications—semi-conductors and ferromagnetic and ferroelectric materials. During 1952 work on noise originating in the receiver included the study of the noise spectrum of point-contact germanium rectifiers over the frequency range 0·1 c/s to 10 Mc/s. From this work it is evident that there are at least three separate components that determine the shape of the spectrum.

Underground Gasification of Coal in Belgium

THE Belgian Government has asked the High Authority of Europe's Coal and Steel Community to finance experiments at Renory, near Liége, in the underground gasification of coal, which have now been held up for fifteen months because of lack of funds. The company which has been making the experiments is the Société Cooperative de la Gazeification Souterraine (SOCOGAZ), founded by twenty-eight private companies in Belgium just after the liberation in 1944. Its finance was provided to the extent of 10,000,000 Belgian francs from private sources, 40,000,000 francs by the Belgian Government and 50,000,000 francs each by the French and Polish mines. The whole of this sum of 150 million francs has now been exhausted—130 million of it on the gasification experiments in Belgium.

SOCOGAZ was on the threshold of major experiments in the use of oxygen for underground gasification of coal when its funds ran out. Earlier experiments had shown that underground gasification with air was possible, but that on the whole the gas obtained using air showed a tendency to deteriorate and the yield in latent energy was mediocre. The company decided it was not worth carrying on with the experiments using air.

The use of oxygen from 1948 onwards showed revolutionary differences. Already widely used in coal gas production, particularly in Germany, to improve the quality of the gas, oxygen showed from the first small-model experiments in 1948 and 1949 that it behaved quite differently from air. Large-model experiments at the surface in steel pipes and in channels dug into the ground showed that gasification with coal occurred regularly and evenly, and not in spurts as with air. The coal was gradually consumed from one end of the block to the other. Most important, the quality of the gas remained constant throughout the operation. Yield and composition of the gas were equivalent to those obtained in gasworks. It now remains to be seen whether gasification using oxygen underground in the coal seams instead of in blocks of coal at the surface will give the same excellent results.

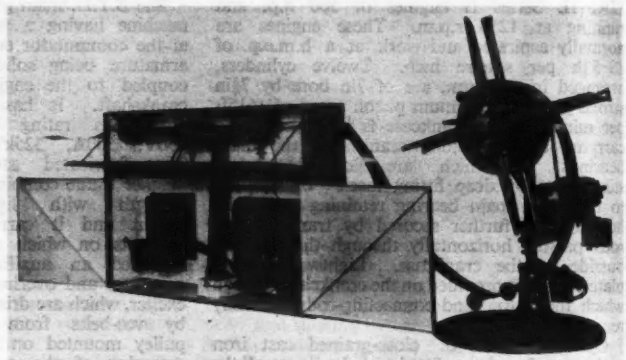
The company visualises gasification in the coal seam underground by boring a series of parallel channels into the seam, each channel being sufficiently near to the next to ensure 100 per cent gasification. But before the multi-channel experiments started it would be necessary to try out oxygen in a single channel to get the preliminary data on its behaviour underground in the seam. Then experiments would be made with three and five channels and so on.

For the boring operations a machine called the "teleborer" has been developed. The teleborer is only 2ft in diameter and 5ft long. The whole machine goes into the seam from a gallery, dragging with it the pipes through which the gas is to flow and pushing out behind it the coal which it removes. It moves three-dimensionally, covering 10 yards per minute in most seams and probably up to twice as fast in particularly favourable seams.

Research on the teleborer is still continuing, the Belgian Government having decided to finance this itself. For the rest of the work it has been estimated that 20,000,000 Belgian francs a year for the next three years will be needed. The president of the direction committee has stated that no other country in the world is as far advanced with underground gasification using oxygen, although the Russians had made experiments with an oxygen and air mixture. In the U.S.A. one experiment was made last November and had given encouraging results despite very unfavourable conditions.

A Long Feed Unit for Presses

THERE is now being manufactured under licence in this country by the Rockwell Machine Tool Company, Ltd., Welsh Harp, Edgware Road, London, N.W.2, a press feed equipment for making long components when using a fully automatic cycle. This equipment, built to the designs of the U.S. Tool Company of America, is a development of that firm's gripper feeding unit. In these units the material is gripped between a hardened pad and a toggle-operated hardened feed finger, both of which are mounted in a feed block. This feed block runs on hardened guide pins and reciprocates between two adjustable stops. The grip on the material and the method of feeding ensures positive clamping and the stops ensure accuracy of pitch when feeding the strip into a press.



Long Feed Unit and Stock Reel

The new "Long Feed," as it is known, makes use of this same method, but whereas other automatic feed units are driven and/or controlled by the press, the "Long Feed" is an independent unit with its own drive and it controls the press. In its standard form the new equipment is capable of handling material up to 6in wide and it feeds up to 24in of material in one stroke.

The feed unit is driven by a motor and reduction gearbox and its electric controls include cam-operated micro switches and an electro-mechanical stroke counter. This counter determines the number of feed strokes and thus the length of material fed between each press stroke.

When, for instance, a component of 24in or less is required the counter in the "Long Feed" is set to "1." This counter, which receives the counting impulse from the cam-operated micro switches ensures that after every feed stroke a contact is closed, which causes the press ram to operate. The press flywheel runs continuously, but the clutch rod is tripped either by solenoid or

air piston whenever the main contacts of the feed counter close. Thus in cases where 24in or shorter lengths are required the "Long Feed" functions in unison with each press stroke, although the feed is the controlling factor.

In cases where longer lengths of, for instance, 60in are required the feed block is set to traverse 20in and the counter set to "3." The unit then feeds out three increments of 20in before the press clutch operates, and the ram descends. The counter is designed to permit the setting of up to 100 pitches.

The "Long Feed" machine, as can be seen in the illustration opposite, is completely enclosed in a cabinet which also houses the drive mechanism and the counter. An effective central lubrication system is provided on account of the high surface speed at which the feed block travels. In order to reduce the inertia forces to be overcome when the feed block starts its travel, the block is made from light metal and is suitably bushed to give long service. A roller check is fitted to the ingoing side of the unit to ensure that material cannot back out of the feed on the return stroke of the feed block. Four micro switches act as safety devices which will stop the feed when closed. One of these switches is built into the roller check and becomes operative when the feed is without material. The other three have sockets and tumbler switches and can be used at strategic positions so as to control buckling of material width or thickness, &c.

For use in conjunction with this unit, which feeds out at a rate of approximately 2ft per second, a special automatic reel capable of paying out the strip at this high rate and a suitable switch control are provided.

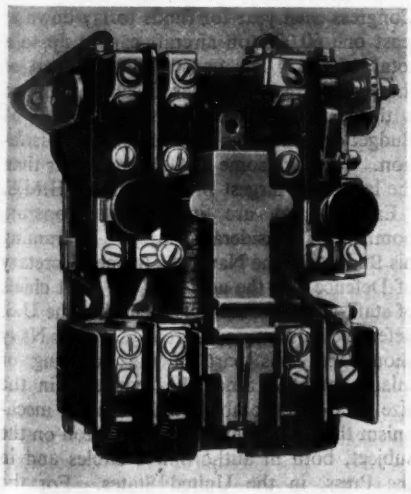
We are informed that it was found that in some instances the "Long Feed" unit with its 24in maximum stroke provided a rather greater capacity than required, and for this reason there has been made available what is known as the "Cycle Feed" unit. This unit is an adaptation of a standard slide feed, and it has its own drive and stroke counter. It differs from the "Long Feed" in one respect only, namely the maximum possible pitch in one stroke is 4in, 8in or 12in, depending on the capacity of the feed used.

A Direct-on-Line Contactor Starter

THE equipment illustrated herewith is a recent addition to the range of direct-on-line starters made by the British Thomson-Houston Company, Ltd., Rugby. This starter has been tested in accordance with the relevant British Standards and complies with B.S. 587 for frequent duty—that is, forty starts per hour. It is suitable for use with drives where the starting current does not exceed eight times the full-load value. For all ratings of the new starter provision is made to withstand 25 per cent overload as defined in B.S 168.

The "DOC 71" starter is designed for use with single-phase or polyphase non-reversing squirrel-cage induction motors up to 5 h.p., 200/550V, 25/60 c/s. Control is effected by integral "start-stop" push buttons and provision is made for remote control. A triple-pole contactor with auxiliary retaining switch is incorporated, as illustrated; silver-faced double-break contacts are used. The contactor opens under gravity, and provides inherent under-voltage protection. Thermal overload relays protect the motor under ordinary working conditions. Resetting, after tripping on overload, is made by pressing the "stop" button.

The starter is enclosed in a cast aluminium box of attractive appearance and is normally arranged for wall mounting. For certain applications, e.g. machine tool, however, starters are available arranged for flange mounting.



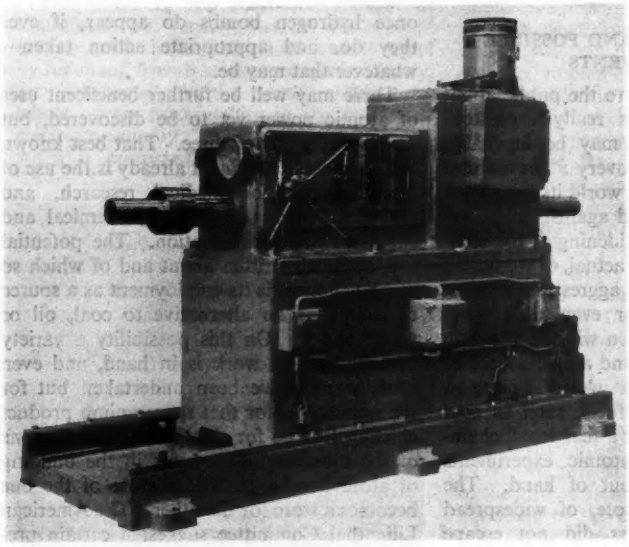
Contactor Starter with Cover Removed

A Fixed Height Drilling, Boring and Facing Machine

PARTICULARS have been received from Kitchen and Wade, Ltd., of Arundel Street, Halifax, of two models of fixed height spindle drilling, boring and facing machines it is now making. These machines are intended for the machining of large components on one centre only, and are designed to relieve the heavy duty horizontal universal boring machines normally used. They are capable of drilling holes up to 4in diameter from the solid, bore-holes up to 24in diameter and of face work up to 30in diameter.

The two models are similar except that one is mounted on a movable base, as shown in the illustration, and one is on a fixed base. Depending upon the duty the main drive is by a 15 h.p. or 20 h.p. motor and is taken through a gearbox to the spindle drive worm and wormwheel. Spindle speeds from 3 to 180 r.p.m. are available. The 4in diameter spindle is bored No. 6 Morse taper and rotates in a hardened steel sleeve.

Power feeds range from 0·0025in to 0·072in per spindle revolution and a reverse motion is fitted for back facing operations. The length of spindle feed is 3ft and the moving base machine has a further 3ft of travel in the direction of spindle feed by rapid power traverse motion.

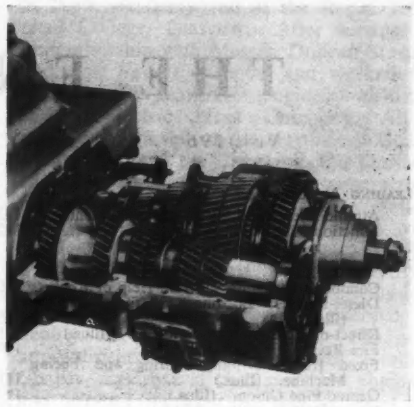


Drilling, Boring and Facing Machine

Heavy Duty Gearbox

AFTER extensive road testing of prototypes by several commercial vehicle manufacturers, David Brown and Sons (Huddersfield), Ltd., has put into production a new constant mesh five-speed gearbox, the David Brown "557 CM," which is designed for commercial and passenger vehicles of 22-tons maximum weight. Whereas the previous model employed crash-type first, second and reverse gears, the "557 CM" box has constant mesh in all gears.

The new boxes, which have direct drive top gears, are suitable for either unit or mid-mounting and can be supplied to suit either right or left-hand driving positions. At the forward end the box has a large facing which, in the unit arrangement, bolts on to the bell housing. When the box is mounted amidships the facing bolts on to a traverse bearer which is supported by the chassis. This arrangement, taken in conjunction with the locations provided at the rear, forms what is virtually a three-point mounting.



Constant-Mesh Five-Speed Gearbox

All gears are of the single helical form of 3½ per cent nickel chrome case-hardened steel, and are shaved after cutting. Tooth forms are of 20 deg. pressure angle, with profiles modified to obviate tip interference under heavy load.

A centre bearing, incorporated in the intermediate wall of the aluminium case, provides independent support for the final shaft. A roller bearing carries the primary shaft and a location bearing takes the axial load from the gears. Three roller bearings support the layshaft, the two outer bearings having lips to locate the shaft axially. The front end of the mainshaft is carried on a roller bearing and on a deep groove ball bearing at the rear. Roller brushes, each with two rows of large rollers, are fitted to each of the loose main shaft gears. An auxiliary drive is provided to accommodate a high pressure brake pump. This pump is at the rear of the gearbox, thereby ensuring that the brakes are energised in all gears, including the neutral gear.

Approximate weight of the gearbox, complete with ball housing and forward control, is 410 lb. For a vehicle of 15-tons capacity and 22-tons loaded weight maximum engine torque is 4200 lb per inch, with a probable minimum axle ratio of 6·25/1. Standard gear ratios are 1 : 1 (fifth), 1·565 : 1 (fourth), 2·74 : 1 (third), 4·68 : 1 (second), and 7·92 : 1 (first and reverse gears).

STEEL COMPANY'S RESEARCH WORK.—We have received from Hadfields, Ltd., Sheffield, a copy of an illustrated book which it has published recently describing the organisation and operation of its research undertaking. The book tells of the research work of the late Sir Robert Hadfield and records the up-to-date methods and equipment employed throughout the present research organisation. In a foreword to the book the chairman of the company, Lord Dudley Gordon, comments that there is no sharp division between pure and applied science, and thus the firm's research department is closely linked and at many points integrated in the production departments.

THE ENGINEER

Vol. 196 JULY 24, 1953 No. 5087

LEADING ARTICLES—

Atomic Energy and Possible Developments ... 112
Function of the Large Carrier 112

ARTICLES—

Conductor Stringing with the Help of Rockets 119
Diesel-Electric Locomotives for Australia (Illus.) 108
Direct-on-Line Contactor Starter. (Illus.) ... 111
Fire Resisting Cables 119
Fixed Height Drilling, Boring and Facing Machine. (Illus.) 111
Geared Pipe Union. (Illus.) 117
Heavy Duty Gearbox. (Illus.) 111
Hydraulic Research Laboratory. (Illus.) ... 120
Institution of Mining Engineers 97
Intrinsic Efficiency of a Flow Type Air Compressor. (Illus.) 101
Lloyd's Shipbuilding Returns 97
Long Feed Unit for Presses. (Illus.) 110
Machining Plant for Turbine Casings. (Illus.) 105
Oil Pollution of the Sea 97
Performance and Efficiency Tests on the "Britannia" Locomotives. No. I. (Illus.) 103
Radio Research in 1952 110
Radio-Frequency Edge-Gluing Machine. (Illus.) 121
Railway Vehicle Re-Railing Equipment. (Illus.) 118
Road Vehicle Factory Extension 107
Scrapping of the "Brabazon" Aircraft 97
Some Problems in Flexural Testing. (Illus.) ... 98
St. Lawrence Seaway 122
Staythorpe-West Melton Section of the 275kV Grid. No. II. (Illus.) 116
Twin-Screw Steamship "Vigilant." (Illus.) ... 106
Underground Gasification of Coal in Belgium 110
Vehicle Braking 97

LETTERS TO THE EDITOR—

Some Notes on Plane Frames not Obeying Hooke's Law 114
Vocational Education 114

LITERATURE 114

Books Received 115
Short Notices 115

OBITUARY—

Sir Johnstone Wright 113
Engineer-Captain W. Onyon, M.V.O., R.N. (Ret.) 114

NEWS AND NOTES—

African Engineering News 124
American Engineering News. (Illus.) 122
British Patent Specifications. (Illus.) 127
Contracts 126
Forthcoming Engagements 128
Industrial and Labour Notes 125
Launches and Trial Trips 128
Notes and Memoranda 126
Personal and Business 126
Technical Reports 128

ATOMIC ENERGY AND POSSIBLE DEVELOPMENTS

If much has been said to the public about atomic energy little has really been told about it. This secrecy may be inevitable with any two-edged discovery: the natural desire to broadcast to the world its beneficent aspect has to be balanced against an understandable dread of any widening of the technique already available to actual, or would-be, dictators of modes of aggression against neighbouring peoples—or even their own. The limits may be set even wider: the gain upon one side of a new and ample source of mechanical power in a world having a limited supply of fossil fuels, such as coal and oil, and on the other a fear lest "chain-reactions" in further atomic experiments might conceivably get out of hand. The possibility, however remote, of widespread destruction in such ways did not escape the attention of the great pioneers in nuclear research, and the world learnt with relief that fissile reactions in the heavier elements, such as uranium and thorium, were unlikely to be dangerous in any such way, and that although the fusion reaction in elements at the opposite end of the atomic scale—hydrogen, helium and lithium, for instance—was potentially more dangerous, no one then knew any way in which such reactions could be produced under terrestrial conditions. That situation has since changed in that "promising" results with hydrogen have been obtained in experiments started in America and no doubt pursued elsewhere; indeed, some sort of "hydrogen bomb" may already have been produced for all we know to the contrary. Even so, as Sir George Thomson pointed out some years ago, the possible danger would lie in the main through the use of certain metals for the bomb casing, which might conceivably have the effect of poisoning the atmosphere over no inconsiderable portion of the earth's surface. This sort of danger would therefore need to be carefully watched once hydrogen bombs do appear, if ever they do, and appropriate action taken—whatever that may be.

There may well be further beneficent uses of atomic power yet to be discovered, but we already know of three. That best known and in wide employment already is the use of radio-isotopes for medical research, and in certain forms of physical, chemical and engineering experimentation. The potential use, so much written about and of which so much is hoped, is its employment as a source of energy as an alternative to coal, oil or water power. On this possibility a variety of experimental work is in hand, and even more would have been undertaken but for the unlucky factor that the uranium product chiefly of value for this purpose is also one of the most useful elements in the building of atom bombs, so that a store of the one becomes a store for the other. The American Lilienthal Committee suggested certain precautions having the object of minimising this difficulty, but such action to be effective would require a degree of international agreement which has so far proved impossible of attainment. A third possible use for atomic energy is the reported new discovery of how to employ it tactically as a highly intense explosive in the artillery branch of national defence; with the welcome prospect of an important addition to the power of defence against large-scale warlike aggression from any direction. It may well be asked whether there is enough uranium ore available for all these uses to be pursued at one and the same time. In considering this point it is perhaps safe to assume that the stockpiling needed for atomic bombs of the Hiroshima-Nagasaki type is no longer a matter of urgent necessity, as stockpiles may by now be nearly or quite large enough. The answer made by geologists to the general question of supply is that the amount of uranium present in the earth's crust is abundant; though mining engineers will no doubt wish to put in the caveat that the metal occurs mainly in such widely dispersed and poor ores as to make recovery difficult and expensive, and but rarely in rich patches which can be easily worked. Fortunately it seems there is a fair prospect of success in the production of what are known as "breeding reactors," in which the consumption of the fissile form of uranium is accompanied by the production of as much, or more, of the equally fissile plutonium. Success is already reported of an experimental breeding reactor built by the U.S. Government in Idaho. According to a recent statement made by Sir John Cockcroft the Idaho reactor has a U.235 core, "about the size of a football," cooled by the circulation of a liquid sodium-potassium alloy on its way to a steam boiler at 250 deg. Cent., which yields about 250kW of power. Nothing is yet reported as to the working cost, nor has any news yet been published as to the results attained in our own experiments in this direction at Harwell.

In the U.S.A. the whole field of this form of research work is fairly evenly divided between public and private industry, but in Britain the share so far allotted to industrial firms is much slighter, though a change may well come as a result of the creation, announced in our issue of May 8th last, of the Waverley Committee having as its objective the securing of the most rapid and economical development in the field of atomic energy, military and civil. Lord Waverley (more familiar perhaps as Sir John Anderson) is known as a great administrator with much knowledge of the problems inherent in the atomic energy field, and we wish him and his fellow-committee members all success in the task which has been remitted to them. The British public has watched with sympathetic interest the activities of the American Atomic Energy Commission and noted the effective way in which the responsibility for the essential experimental development has been divided between the American Government technical establishments and industrial firms; it is likely that any recommendation favouring the creation of a corresponding British Atomic Energy Commission would be cordially welcomed.

THE FUNCTION OF THE LARGE CARRIER

The United States naval authorities have made no secret of their intention to ask Congress each year for funds to lay down at least one 60,000-ton aircraft carrier up to a total of ten. The construction of two of these very large vessels has already begun and a third has been included in the 1953–54 Budget drawn up by the Truman administration. They are some 23,000 tons larger than the latest and largest British carrier—H.M.S. "Eagle"—and are intended to operate bombers of considerable range. In framing his Budget for the Navy, the former Secretary of Defence had the advice of the joint chiefs of staff, and it would thus seem that the U.S. defence chiefs are now agreed that their Navy should play its part in the bombing of inland targets. Since the reduction in the size of atomic bombs and their firing mechanism there has been much discussion on the subject, both in authoritative circles and in the Press, in the United States. For the naval chiefs insist that aircraft which are lighter, faster, more easily manœuvrable and

much more difficult to intercept than the long-range land-based bomber, now have atomic capabilities. Their views have, moreover, been strengthened by the development of guided missiles, which are bound to have a profound influence on the future of the long-range, land-based bomber. The ground-to-air missile is likely to be an effective counter to all but the fastest-flying, highest-altitude bombers, while the surface-to surface missile may eventually substitute the piloted bomber entirely. The United States authorities clearly have these developments in mind, for only a very small production order has as yet been given for the giant "B-52" jet bombers, which are to replace the much slower "B-36" on which so many hopes were placed. On the other hand, two squadrons of "AJ-I" medium-range carrier-based aircraft have already been equipped to carry atomic bombs.

The cost of the "Forrestal" and "Saratoga," the two carriers now under construction, is estimated at about £78,000,000 for each ship. These ships are to be 1040ft in length with a beam of 250ft, and they will have a specially strengthened flying deck of flush-deck design with no superstructure. The bridge will run the entire width of the ship, just under the flight deck, about one-third the length of the ship from the bows, with wings at each end giving a view ahead, to port and to starboard. A small "island"—a retractable superstructure—will also be provided as an observation post. Four steam-operated catapults of British design will be fitted and both vessels will be identical except for a more powerful propulsion plant in the "Saratoga," giving a speed of 35 knots—about 2 knots faster than the "Forrestal." The immense cost of these giant carriers may well account for the lack of interest in this country in the land-based versus carrier-based bomber discussion in the United States. Royal Navy carriers have no longer to provide reconnaissance and strike aircraft, preliminary to a battle fleet action. But apart from anti-submarine operations, they are intended to operate jet fighters and fighter bombers for the tactical support of troops in combined operations, pending the establishment of Air Force bases on shore. They must therefore be large enough and fast enough to operate modern heavy jet fighters capable of competing on equal terms with land-based aircraft—a requirement which demands a steady platform, a long runway and ability to operate in a seaway. None of these can be provided by the small carrier.

But unless and until we accept the United States Navy view that any worthwhile target can be reached by medium-range, carrier-borne bombers, there seems no need for carriers larger than the 36,800-ton "Eagle." Indeed, it was suggested by high-ranking Air Force officers in a recent debate in the House of Lords that even the very few large carriers we have now are unnecessary and a waste of effort. This view, however, is based, not on technical considerations, but on the highly debatable premise that an enemy's ability and will to carry on a war would soon be destroyed by strategic bombing—the bombing of war potential factories and installations and centres of population—by "Victor," "Valiant" and "Vulcan" bombers. Atom bombs—if they are ever used—will vastly increase the destructive effects of an air raid. On the other hand, Russia's centres of industry and population are widely dispersed over large areas. Moreover, Germany was bombed incessantly day and night from 1942 onwards—large areas of towns were in fact almost obliterated by area bombing. Yet her total armament production continued to increase—60 per cent more in 1943 than in 1942 and 23 per cent more in 1944 than in 1943. It was only when the Allied Air Forces reverted to their proper role of bombing military communications behind the enemy lines that the German armies finally collapsed in 1945. It is much to be hoped that such extreme views will not receive wide support. For without large carriers the N.A.T.O. nations would be deprived of their ability to undertake the kind of offensive which is always open to sea power—the invasion and capture of vital strategic coastal areas and landings on the territories of satellite countries to encourage and support underground movements.

Obituary

SIR JOHNSTONE WRIGHT

THE death of Sir Johnstone Wright at Guildford, on Sunday last, at the age of seventy, will have been noted with regret by his many friends in the electrical industry. Sir Johnstone Wright spent almost the whole of his working life in the service of electricity supply. He joined the industry when it consisted of a large number of individual and independent undertakings and he gained experience of both in the privately owned and municipally owned sections. He saw the first major evolutionary change in the industry, when the Central Electricity Board was set up to co-ordinate the generation and main transmission of electricity through the medium of the grid. Finally as chairman of the Central Electricity Board, he witnessed the complete transfer of the supply industry to public ownership and control.

Sir Johnstone Wright

Johnstone Wright was born in Perthshire on January 22, 1883, and he was educated at Perth Academy and at the Royal Technical College, Glasgow. After serving an apprenticeship with Messrs. Duncan Stewart and Co., he left Glasgow and worked for two years as contracts engineer with the British Electric Plant Company, Alloa. In 1905 he moved to the North-East Coast, where he joined the Cleveland and Durham Electric Power Company as construction engineer and later became power station superintendent. His first association with municipal electricity supply began in 1919 when he was appointed assistant electrical engineer to the Bradford electricity undertaking and in 1920 he was promoted to deputy city electrical engineer. His next appointment, in 1922, again with a municipality, was that of chief electrical engineer and general manager of the Belfast Corporation's electricity undertaking.

He left Belfast in 1927, when he was appointed deputy chief engineer of the Central Electricity Board, and he remained with the Board, as chief engineer from 1933–44, as general manager from 1944–47, and as chairman from 1947 until 1948, when the Board was dissolved on "vesting date"—the date when the whole of the electricity supply industry passed to public ownership. Sir Johnstone therefore served on the Board throughout its existence and it is with the Board's achievements that his name is mainly associated. It will be recalled that the purpose of the Board (which was set up under the Act of 1926) was to implement the Weir Committee's recommendation that generation and main transmission of electricity should be divorced from the function of local distribution. Briefly, the Board, acting as a non-profit-making body, was required to establish an interconnecting grid, to control generation without owning the stations, and to provide the authorised undertakers with a cheap and abundant supply of electricity for local distribution. Inasmuch as the Board was charged with the co-ordination of plant that it did not own, its task was a delicate one.

A record of the way in which the Board set about its task was given by Sir Johnstone Wright in his inaugural address as President of the Institution of Electrical Engineers in 1939. In this address he gave an account of the grid as an established entity, summarising some of the experience gained and progress made from an engineering and national standpoint since the passing of the 1926 Act. He wrote: "It is not too much to say that the grid has brought about a revolution in the outlook regarding the provision of new generating equipment. Indeed, the co-ordination of generating plant development may well prove ultimately to be the greatest of the contributions of the grid towards the advancement of the supply industry. Previously new generating facilities were provided piecemeal as required by the load increment of the individual undertakings and the size and type of set were more or less rigidly determined by local load prospects in the years immediately ahead."

The subsequent operating results of the grid have been given in the annual reports of the Central Electricity Board, which show the economies achieved by increasing the concentration of generating plant on the more suitable sites and by securing the closing down of the smaller and less efficient stations. For example, it is stated that the net annual saving to the supply industry by grid operation amounted, by 1937–38, to over 17 per cent of the costs of production, which would otherwise have been incurred. During

the second World War the grid system (which was originally intended to operate under the control of areas) was normally run as a single national unit. National control was imposed primarily to achieve a still more effective pooling of generating plant, to enhance security by improving mutual assistance between areas and to save transport of coal by transferring electrical energy between areas up to the capacity of the transmission lines available. Some of the economies made possible by grid operation are reflected by the fact that, in 1925–26, the average price charged by the electricity supply industry to its consumers was 1·65d. per unit and that by 1946–47 the price had been reduced to 1·08d. per unit, although the price of fuel had increased, in the interim, by 250 per cent.

When the Central Electricity Board was dissolved on April 1, 1948, Sir Johnstone Wright, who was then chairman of the Board, retired. For his services during the war he had been knighted in 1943. From 1944–47 he was a member of the Fuel Research Board. He was also a member of the Institution of Civil Engineers. On his retirement from the C.E.B. he became a director of British Insulated Callender's Cables, Ltd., and when the British Insulated Callender's Construction Company, Ltd., was formed in 1949 he became deputy chairman of the new company, a position which he held until he retired from the Board in September, 1952.

ENGINEER-CAPTAIN W. ONYON, M.V.O., R.N. (Ret.)

As we go to press we learn with regret of the death of Engineer-Captain William Onyon, R.N. (Ret.), which occurred on Sunday last, July 19th, at Plymstock, Devon. Engineer-Captain Onyon, who had just passed his ninety-first birthday, was educated at the Royal Naval College, Greenwich, and began his naval career in 1885. His appointments included that of Engineer-Commander in H.M.S. "Dreadnought." After his retirement from the Navy he was for some years manager of the Dalmuir works of William Beardmore and Co., Ltd., and was subsequently the London representative of Vickers-Armstrongs, Ltd., Barrow. Captain Onyon was a past-president of the Institute of Marine Engineers, was a member of the Institution of Civil Engineers, and had served on the council of the Institution of Naval Architects.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SOME NOTES ON PLANE FRAMES NOT OBEYING HOOKE'S LAW

SIR,—As the above article by Mr. King in your issue of July 3rd deals with an aspect of structural mechanics which is particularly interesting to me, I would like to comment upon it in the following paragraphs.

The laws of structural theory which are cited by Mr. King (Nos. 1 to 4) depend upon the assumption of linear load-deflection characteristics, both of the individual members and the structure as a whole. It is surprising, therefore, that one of them, Castigliano's First Theorem, is reintroduced as being applicable to non-linear structures provided that gross distortion under load is absent. Now Castigliano's First Theorem states (using Mr. King's notation) that :—

$$\Delta=\frac{\partial U}{\partial W}$$

where U is the internal or strain energy of the structure. Its proof can be found in most standard text books on structural mechanics and there is no doubt whatever that it is entirely dependent upon the assumption of linearity. If U is expressed as a function of the N internal forces $P_i(i=1, 2, .., N)$ which depend upon the loading W, then it is possible to rewrite the above equation as follows :—

$$\Delta=\sum_{1}^{N}\frac{\partial U}{\partial P_i}\cdot\frac{\partial P_i}{\partial W}$$

or

$$\Delta=\sum_{1}^{N}\delta_i\cdot\frac{\partial P_i}{\partial W}$$

It should again be noted that $\partial U/\partial P_i=\delta_i$ only when the structure is linear.

The really interesting point which now emerges is that the last of the above equations is, in fact, valid for structures with non-linear members provided that gross distortion under load is absent. The reason for this is that for linear or non-linear conservative structures for which there is no gross distortion under load :—

$$\Delta=\sum_{1}^{N}\frac{\partial C}{\partial P_i}\cdot\frac{\partial P_i}{\partial W}$$

where C is the Complementary Energy i.e.

$$\sum_{1}^{N}\int_{0}^{P_i}\delta_i.dP_i,$$

and $\partial C/\partial P_i=\delta_i$ in all cases regardless of the law of the load-deflection curve.

The statement that $\partial P/\partial W$ is constant appears to imply that P/W is constant ; while this is undoubtedly true for both linear and non-linear statically determinate structures when there is no gross distortion under load, it is untrue, in general, for non-linear redundant structures, even when gross distortion is absent.

It would appear that Mr. King's ingenious numerical method owes its apparent success to the choice of a statically determinate frame for the purpose of its demonstration.

Finally, there is no difficulty in analysing non-linear conservative redundant structures (whether or not gross distortion is incurred by the loading), by the straightforward, though laborious, method of setting up and solving simultaneously the equations for equilibrium and those for the compatibility of strains. The principle of stationary total potential energy (as distinct from strain energy) can also be used for the same purpose, if desired, since it does not depend in any way upon particular load-deflection characteristics. The principle of stationary complementary energy, however (of which Castigliano's so-called least work principle corresponds to a particular case) is applicable to redundant structures with non-linear members, only if gross distortion under load is absent.

It seems to me, as I have inferred elsewhere (*Engineering*, Vol. 174, No. 4521, September 19, 1952, pages 389–391) that Castigliano's theorems, elegant as they are for linear structures, are primarily responsible for any confusion which may exist of the general principles of structural mechanics.

T. M. CHARLTON

Stocksfield, Northumberland, July 6th.

VOCATIONAL EDUCATION

SIR,—Your contributor of the article "Vocational Education," in the issue of June 26th, in stating that "educate" is from Latin "educere" and in defining education as the "process . . . directed to inducing a man to exercise those faculties which lie latent within him," is (1) wrong etymologically and (2) perpetuating a popular misapprehension. "Educate" comes from "educatus," not from "educere," and the Oxford Dictionary states :

Educate f. L. educat- ppl. stem of "educare," to rear, bring up (children, young animals), related to educere, to lead forth (see EDUCE), which is sometimes used nearly in the same sense.

Although both educare and educere were connected in Latin, Cicero only by very distant derivation uses educere for "bringing up the young" and almost exclusively uses it for "drawing a sword" or similar objects. Neither Latin verb was used passively of a person, as is done predominantly to-day in English. "Educare" was used as in "producing eggs" or (actively) "to train a person" in the sense of "taking or drawing *him* out of," e.g. ignorance, sloth, ineptitude, *not* in the sense of "drawing something latent out of him." This latter is only a derived sense, probably due to the reasoning of Locke and J. S. Mill, who gave the word a breadth far beyond its etymological roots and who caused "education" and "eduction" to become almost synonymous.

Words are often endowed with attributive and subordinate meanings and then one of those meanings later becomes the principal one. Your contributor puts himself out of the semantic court, too, by writing "education . . . is inducing a man," thereby admitting a two-way motion. Of course, he *can* have it both ways, but the principal meaning of "educate" still remains (briefly) "training by teaching through discipline to learn." "Educate," like so many words of simple origin, has become a very "rich" word (not only having several meanings separately, but capable of being used with several meanings at once). In technical training where instruction, demonstration and explanation must precede practice in the handling of tools and machinery, the doctrine of "have a go !" as the battle-cry of "education" can be pernicious, foolhardy and dangerous. Furthermore, it is the "educated" man who reaps the full benefits of and who is the most profitable recipient of a "technical" training. (But that is another story.)

F. H. WILLGOSS

Weymouth, July 18th.

Literature

The Principles and Practice of Management. Edited by E. F. L. BRECH, B.A., B.Sc. (Econ.), with Associate Authors R. M. ALDRICH, A. W. FIELD, B.Sc., J. MADDOCK, F. L. WOODROFFE. London : Longmans, Green and Co., Ltd., 6 and 7 Clifford Street, W.1. Price 50s.

THIS book is a comprehensive study from the British standpoint of a very important subject, and the manner of presentation is somewhat unusual in that there are four distinct sections which are contributed by four different authors, each a specialist in his own branch, these sections being co-ordinated by Mr. Brech, who writes an introduction and a conclusion. A leading industrialist once affirmed that the qualifications for a good manager were 10 per cent technical knowledge and 90 per cent common sense. While this may perhaps be true, it is suggested that to be able efficiently to apply the said common sense, the knowledge of the remaining 10 per cent must be of a very high order, and this is where the work before us will help, indeed, every engineering manager, foreman and student cannot fail to profit considerably by a careful perusal of its pages. As is always the case a book of this nature affords a stimulus to thought bearing, in mind the readers own particular problems.

After an introductory section dealing generally with management in principle and practice, its policy and organisation, the first main part is devoted to the important

subject of distribution with seven chapters covering sales management, planning and organisation, the channels of distribution, the function of the sales department, advertising and physical distribution. In the second part we find our attention concentrated on matters concerning production, not only as regards organisation, administration and supervision, but also explanations of the functions of design, estimating, equipment, planning, inspection and other ancillary services. The third part introduces us into the realm of the personnel department, one that has grown in importance in recent years, the whole subject being treated in a very thorough and helpful manner. Part IV deals with the various aspects of control, of which perhaps the most useful section is that on budgetary control, although the chapters on cost control and clerical management also deserve careful reading. As has already been mentioned, the concluding section, which examines management in practice, in a way co-ordinates the preceding parts. Such is a general survey of an interesting and instructive volume, rendered the more useful by the different charts included and also the bibliography at the end of each part.

No work of this nature could fail to evoke criticism, from organiser and manager; indeed, if it were not so the value of the authors' efforts might be doubted. We feel that the statement that all other kinds of organisation than the functional "may be written off" is too drastic, for it should be remembered that about 70 per cent of British factories are relatively small, and many are run on "military" lines. While the author speaks of "so-called conflicts" between manager and functional chief, we suggest that these conflicts are too often very real, but would be in great measure eliminated if instructions were only allowed to be given by one supervisor. Again, we can hardly agree that "estimating is an activity which is carried on continuously only in those companies who manufacture to customers' special requirements," for it would be easy to name a number of concerns which manufacture largely for stock and yet attach considerable importance to their estimating department, which is worked in close co-operation with that of costing; indeed, the combined effort places a most useful tool in the hands of the management. Again, we should like to see a note on the necessity for satisfactorily interlocking the cost account with the general financial account, for it should never be a case of "reconciliation." We deem it is not wise for inspection to be placed under the works manager, whose desire to produce a maximum output may influence a decision as to the passing or rejection of a border line case. The definite ruling should rest with the chief inspector. While we agree that straight piecework is generally speaking the most satisfactory method of payment by results, perhaps the authors have been unduly severe on some of the other incentives, such as profit sharing, which have been applied successfully in certain industries. In connection with the selection and promotion of staff it is considered desirable for the department concerned to be represented at all interviews as well as the personnel department. With regard to the training of supervisors the value of visits to other factories has proved very beneficial.

Turning from suggestions we find that a number of statements made deserve attention, and the authors have done well to stress the necessity for letting employees be "more in the know" as to what is being undertaken, and how it is desired to make the undertaking a "happy ship." There is food for thought in the pronouncements that "selling is a human and personal thing" and that "a satisfied customer is one of the best salesmen a firm can have," all very true, but often not remembered. We agree most heartily that the difficulty of communicating information and ideas is attributable to the neglect of "the art of speaking and writing good English." Too frequently parents and teachers encourage youths to specialise before they have had a thorough general education. The value of "concentration in advertising" is carefully considered and the ideas set out will be found very helpful. We are told that "in recruitment the personnel department acts as agent"; if this principle were fully applied there would be less friction between shop foremen and "office," and labour turnover would be reduced. The remark that what is set before the reader "must be adapted to the special requirements of each case" in a manner disarms criticism.

Mr. Brech's concluding remark that "there can be a full and rising social standard of life only if sound management is the foundation of all economic endeavour," is claimed by him to be "that simple truth which is the justification" for the volume we have before us, one which we consider may well be retained by the manager as a book of reference after a careful reading of it.

Symposium on Prestressed Concrete Statically Indeterminate Structures. London: Cement and Concrete Association, 52, Grosvenor Gardens, S.W.1. Price 25s.

In September, 1951, the Cement and Concrete Association held a symposium at the Institution of Civil Engineers, at which a number of papers on the problems of statically indeterminate prestressed concrete structures were presented and discussed. The complete proceedings of the symposium have now been published in this volume. The general problem facing the designer of such structures is that the application of prestress to a statically indeterminate structure does itself induce strains, which cause further modifications of internal stresses and reactions in addition to the direct effect of the prestressing force. The analysis of the secondary effects may be complicated, but once it is understood, the statically indeterminate design may possess considerable economy. Most of the prestressed concrete structures built up to now have been statically determinate, and it was felt that prestressed concrete would be able to compete more favourably with other materials if problems of continuity were better understood and hence more generally applied. The volume therefore consists of seven papers, written by well-known exponents of prestressed concrete design, each devoted to some particular aspects of statically indeterminate structures, and of the discussions which took place at the symposium and the authors' replies to the various points raised.

The seven papers presented at the symposium were as follows:—"Continuity of Prestressed Concrete Structures: the Practical Aspect," by A. J. Harris; "The Analysis of Statically Indeterminate Structures Subject to Prestress," by D. W. Cracknell and W. A. Knight; "Some Experimental Work on Interconnected Prestressed Beams," by P. B. Morice; "Continuity in Prestressed Concrete," by Professor G. Magnel; "Determination of Continuity Moments in Prestressed Continuous Beams," by E. G. Trimble; "Continuity Using Post-Tensioned High-Tensile Alloy Steel Bars," by G. O. Kee and S. Jampel; and "A Theoretical Treatment of Continuity in Prestressed Concrete," by Y. Guyon.

As might be expected, comment and criticism is to be found in the discussions, as well as some indications of the future possibilities of this class of design. Of particular interest were the details of a design submitted for Coventry Cathedral, which is described in the discussions, involving a bold and original application of prestressed concrete and an anticlastic shell roof.

SHORT NOTICES

Physical Constants of Some Commercial Steels at Elevated Temperatures. Edited by the British Iron and Steel Research Association. London: Butterworth's Scientific Publications, Bell Yard, Temple Bar, W.C.2. Price 21s.—For many years, the Alloy Steels Research Committee, through its Thermal Treatment Sub-Committee under the chairmanship of Mr. P. B. Henshaw, received reports from the National Physical Laboratory on some of the physical constants of various commercial steels in which they were interested. These have now been collected together, edited by members of the staff of B.I.S.R.A., and published with a foreword by Dr. Ezer Griffiths, who has himself carried out or supervised the measurements reported. The steels cover a wide range of composition: Armco iron, carbon steels with 0·06 to 1·22 per cent of carbon, low-alloy steels up to 3½ per cent nickel-chromium-molybdenum steel, and high-alloy steels, including an additional group of high-temperature, heat-resisting steels used in gas turbines. The properties determined were specific and total heats between 50 deg. and 1300 deg. Cent., linear expansion between 0 deg. and 1200 deg. Cent., thermal conductivity between 0 deg. and 1000 deg. Cent., and electrical resistivity between 0 deg. and 1300 deg. Cent. Mean specific heats, thermal diffusivities and coefficients of expansion over ranges of 50 deg. Cent., and densities at different temperatures, were derived from the experimental data. In order to make the results more readily available for use in calculations all the constants are presented in tabular form at intervals of 50 deg. Cent. In addition, there are curves showing the variation of total heat and thermal expansion with temperature. A brief account of the methods used in determining the constants is given, and it is interesting to note that the work is being extended, and that special apparatus has recently been constructed for determining the specific heats of steels at temperatures up to and above the melting points.

This useful compilation presents reliable data of the kind required in quantitative heat-flow calculations in a convenient form for use by engineers and metallurgists concerned with the heating and cooling of masses of steel.

BOOKS RECEIVED

The Builder's Reference Book. Second edition. London: H. O. Quinn, Ltd., 151, Fleet Street, E.C.4. Price 5s.

Leadership in the Factory. By John Munro Fraser. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 3s.

Prestressed Concrete. By Y. Guyon. London: Contractors Record and Municipal Engineering, Lennox House, Norfolk Street, W.C.2. Price 70s.

Graded List of Scientific Films. Prepared by the Film Committee of the Association of Scientific Workers. London: Harvey and Blythe, Ltd., 212, Shaftesbury Avenue, W.C.2. Price 6s. 6d.

Atlas of the World's Resources, Vol. II. The Mineral Resources of the World. By William van Royen and Oliver Bowles. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 70s.

Mechanics for Engineering Students. By G. W. Bird. Fourth edition. Revised by F. J. Batson. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 10s. 6d.

Definitions and Formulæ for Students, Automobile Engineering. By H. Kerr Thomas. Second edition. By Staton Abbey. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 1s.

The Science of Petroleum. Volume V, Part II: Synthetic Products of Petroleum. General editors: B. T. Brooks and A. E. Dunstan. London: Oxford University Press, Amen House, Warwick Square, E.C.4. Price 100s.

The Staythorpe-West Melton Section of the 275kV Grid

No. II—(*Concluded from page 76, July 17th*)

Some details of the 275kV Supergrid are given here, to mark the inauguration by Sir John Hacking of the first section of the system—the line from Staythorpe to West Melton. It is recalled that work had already been started on this line, as a trial section, before the scheme for the Supergrid had been authorised.

AS stated briefly in last week's article, the first section of the supergrid to be energised at 275kV is the single-circuit 42-mile overhead line from Staythorpe to West Melton. It links Staythorpe power station, which is on the East Midlands coalfields, with West Melton, which serves as a marshalling point for power stations on the Yorkshire coalfield. The line will therefore be used mainly for providing interconnection between the power stations, rather than for bulk power transmission.

It is a single-circuit line, with the three phases disposed horizontally at a spacing of 32ft 6in, each phase consisting of two steel-cored aluminium conductors of 0·175 square inch equivalent copper section, at 12in centres, and there are two earth wires. It will be recalled that work on this line was put in hand, in order to gain early experience, before the decision had been reached to proceed with the main 275kV grid. The single-circuit construction used between Staythorpe and West Melton would not, however, have been suitable for the 275kV system as a whole, because it would have involved too many separate routes and would have introduced substantial wayleave difficulties. For the new system, therefore, apart from the Staythorpe-West Melton line, it was decided that all lines should be of double-circuit constructon of two standard designs. The first, using twin 0·175 square inch (equivalent) conductors at 12in spacing, are to serve mainly as interconnectors; while the second, using twin 0·4 square inch (equivalent) conductors at 12in spacing, are to serve for bulk transmission as well as interconnection.

West Melton

In last week's article we reproduced some photographs of Staythorpe substation. Here we illustrate some of the equipment installed at the West Melton substation.

The first illustration shows the 120MVA three-phase auto transformer, with a voltage ratio of 275/132kV, which was supplied by the English Electric Company, Ltd. Anti-fog bushings are provided on both 275kV and 132kV sides of the transformer.

To meet transport limitations the core is of five-limb construction, and the tank is shaped to follow the general plan contour of the windings—a construction which results in a strong tank, a considerable reduction in weight, and a very clean appearance. The cooling is O.N./O.F.B., provided by two radiator banks, as illustrated. The transformer is designed to be operated with a solidly and permanently earthed neutral, which allows graded insulation to be used. Both 275kV and 132kV windings are of the company's interleaved construction, which gives a greatly improved initial voltage distribution under impulse conditions. Subsequent voltage oscillations are considerably reduced, so that the winding insulation is more uniformly stressed under all impulse conditions. Before leaving the maker's Stafford works the transformer was fully tested under impulse conditions, and successfully withstood what are believed to be the highest test voltages so far applied to transformers for service in this country. These were 1050kV full wave and 1200kV peak chopped wave tests. The transformer was transported to site in its own tank without oil, the transport weight being 87 tons. The total weight of the completely erected transformer in service is 164 tons.

Main Particulars of 275kV Air-Blast Circuit Breaker at West Melton

Service voltage	275/300kV, 3-phase, 50 c/s
Normal current rating	800A
Symmetrical breaking capacity	7500MVA
Symmetrical breaking current	15·8kA
Asymmetrical breaking current	19·4kA
Peak making current	40·2kA
Operating duty	B-3-MB-3-MB
Impulse level	1050kV withstand (1/50 micro-sec wave)
H.V. test (1 min. 50 c/s)	485kV
Normal working pressure	300 lb per square inch
Number of stored operations in local receiver	two make-break

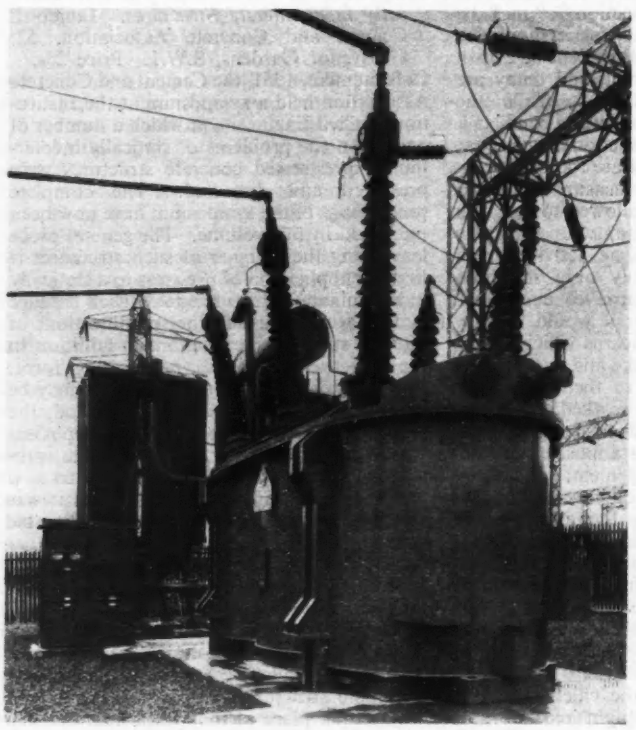
To provide service experience a 275kV three-phase English Electric air-blast circuit breaker has been installed, on an experimental basis, at the West Melton substation. As illustrated opposite, this circuit breaker consists of three identical single-pole units coupled together electrically and pneumatically. Each single-pole unit comprises six identical interrupters connected electrically in series and mounted in two vertical columns, and each column is carried on a supporting structure of porcelain insulators with a triangular base.

The interrupters are of the axial-blast design shunted by porcelain-clad non-linear resistances, and are identical to the interrupters used on the company's 132kV, 2500MVA and 3500MVA air-blast breakers in operation elsewhere on the Authority's system. The two columns are connected electrically by double make-switch blades, operated from air engines in the mechanism housing. An air jet is provided through the blades for icebreaking purposes. The current transformers are separately mounted in oil-filled porcelain-clad enclosures. The design incorporates a hairpin primary winding with graded insulation designed to meet the test specification for the circuit breaker. Five secondary windings can be incorporated, having a nominal ratio of 600/1 and capable of operating up to 1200A primary current. The oil chamber is hermetically sealed via an oil trap.

The local air receivers are mounted at the base of the support columns adjacent to the weatherproof cabinets which house the blast valves, control valves, anti-hunting relay and mechanically driven auxiliary switches. Compressed air is carried from the base to the interrupters and make-switch operating air engines via the support insulators. Air is compressed and stored at 600 lb per square inch in outdoor mounted receivers fed from standard compressor units. It is fed via an automatic reducing valve at a pressure of 300 lb. per square inch through duplicate bus air pipes to the circuit breaker control cabinets, where stop valves are provided, and thence to the breaker receivers. The pressure cycle ensures that the air is effectively dried, thus preventing condensation in the breaker receivers. The whole process of supply of the compressed air is fully automatic.

Local control of the circuit breaker and marshalling of multicore cables, valves, &c., for connecting the breaker to the main air supply bus pipes, are provided in a weatherproof galvanised steel cabinet supplied with each equipment.

For easy inspection and maintenance the blast-valve, control valves, &c., are in the cabinet at the base of each phase, and the contacts can be removed through the inspection doors. A steel ladder which can be fixed to the side of the breaker is provided to give access to the interrupters, and the contacts on one column can easily be removed in under ten minutes.



120MVA, 275/132kV, Auto Transformer at West Melton

Inauguration at Staythorpe

At the invitation of the British Electricity Authority we attended the inaugural ceremony at Staythorpe on Wednesday, July 15th, when Sir John Hacking, deputy chairman (operations) of the Authority, formally energised the Staythorpe-West Melton section of the 275kV grid.

The ceremony took place at the Staythorpe 132kV substation, on a temporary platform and control desk which was in telephonic communication with the grid control centre in Birmingham, whereby the formality of authorisation for switching the new line at Staythorpe was carried out.

The new 275kV line is connected at the Staythorpe substation through a 275/132kV auto transformer, a length of 132kV oil-filled cable, a 132kV bulk oil circuit breaker, and a 132kV reserve busbar isolator to the 132kV system.

At about 12.35 p.m., after the necessary verbal authorisation had been obtained, the reserve busbar isolator was closed manually, placing the 132kV oil circuit breaker under remote control at the temporary control desk, where Sir John Hacking operated a push button to energise the line, through the transformer, at 275kV. At this stage the capacitive charging current for the line, of about 40A, was taken from Staythorpe. Manual closure of a breaker at West Melton then completed the interconnection at 275kV. A temporary demonstration board carrying a mimic diagram and various indicating instruments erected beside the inaugural platform, showed the progress of events during the energising of the line. Under the conditions prevailing at the time an import of some 60MW from West Melton to Staythorpe was observed.

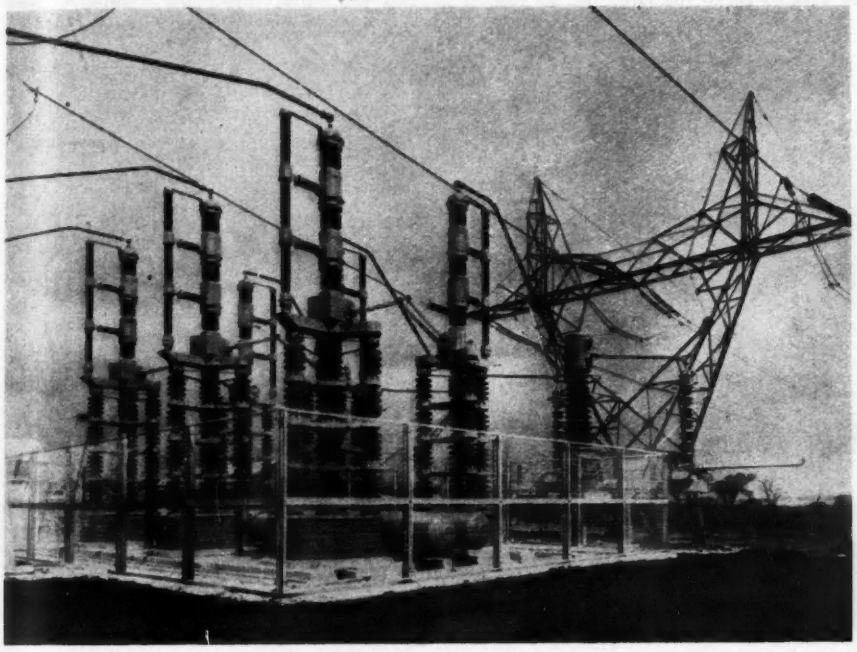
At a luncheon after the inaugural ceremony the toast of "The Guests" was proposed by Mr. L. F. Jeffrey, controller of the East Midland Division, B.E.A. Colonel Leeson, who responded, said that the Supergrid marked an epoch in electricity supply in Great Britain and

in that country's industrial development. It was, he said, a long-term scheme which could be extended to higher voltages as the need arose. He pointed out that the use of a number of different designs of circuit breaker allowed for the full exercise of technical competition and progress. The interests of standardisation had, however, been upheld in the case of isolators.

Mr. T. G. N. Haldane, who also responded on behalf of the guests, recalled some of the names associated with the twenty-four-year-old 132kV grid and with the conception of the new Supergrid. Mr. Haldane went on to stress the fact that the consultants' activities abroad were, perhaps, the spearhead of Great Britain's export drive. It followed that, by employing consultants on home contracts, the B.E.A. was making a useful contribution to the country's export efforts.

275kV Cable Testing Station

After lunch we had the opportunity of visiting the 275kV cable testing station which is being established on a small site near the overhead line about half a mile from Staythorpe substation.



275kV Air-Blast Circuit Breaker at West Melton

Although it may be some time before 275kV cables are required commercially, it was agreed, jointly by the British Electricity Authority and the Cable Makers' Association, that a site should be provided now, where test lengths of cable could be tested under service conditions for a period of approximately two years.

Provision is being made at the cable testing station for carrying out various tests at 275kV on lengths of cables with straight-through joints and sealing ends. During the time the cables are on test, the surges to which they are subjected will be measured by a surge recorder. Measurements of sheath temperature will be taken to ascertain the maximum temperature of the conductor during load cycles, and records will also be kept of the voltage and load on the overhead line.

The 275kV test supply is brought from one phase of the overhead line at the tower which adjoins the site. The test cables are connected in a series loop to the line through an isolator with by-pass isolators, so that work can be done on any of the cables without interfering with the tests on the remainder.

At present provision is made for testing at 275kV a B.I. Callender's impregnated pressure cable and an oil-filled cable by the same maker, a Pirelli-General oil-filled cable and a cable produced jointly by Enfield Cables, Ltd., and Standard Telephones and Cables, Ltd. Four test positions are set aside for these cables and a fifth position is not as yet allocated.

In each case the cable consists of a 100-yard length of single-core cable including one straight-through joint and terminated at each end by a sealing end.

An interesting point about the design of the test cables is that provision is made for simulating the full heating effect of a throughput of 350MVA, in spite of the fact that the present loading of the cables is limited to 120MVA by the capacity of the 275kV transformers at Staythorpe and West Melton. The B.I.C.C. impregnated pressure cable is designed to operate at a maximum stress at the conductor of 110kV per cm, under a nitrogen pressure of 200 lb per square inch. A special conductor arrangement was adopted so that the conductor will attain a temperature of 80 deg. Cent., the maximum designed temperature for such cables operating under full load conditions ; in all other respects the cable will be similar to those offered for commercial use. The conductor arrangement of this special cable consists of a stranded centre made up of sixty-one 0·083in aluminium wires covered with a paper separator over which is stranded a single layer of forty-seven 0·066in aluminium wires which will actually carry the current, giving an effective conductor area of 0·16 square inch. This conductor is screened with metallized paper tapes over which the paper insulation is applied. The lead alloy sheath is reinforced with bronze strips applied longitudinally and circumferentially. The overall protection consists of the rubber bitumen sandwich serving developed by the manufacturer. The final overall diameter is 3·87in.

The B.I.C.C. installation includes a straight-through joint of a new type. The electrical design follows similar practice to that used for lower voltage impregnated-pressure cables, but the cast plumbs have beeen replaced by a mechanical sealing arrangement and the inner lead sleeve has been omitted.* The conductors are joined by soldering, the overall diameter of the joint being equal to the diameter of the conductor, but it is not necessary to preserve the insulation between the wire centre and the conductor itself as, at the sealing ends, connections are made only to the conductors.

Each sealing end is a condenser cone arrangement housed in an anti-fog porcelain capable of withstanding the internal pressure of 200 lb per square inch. The use of this condenser cone arrangement permits the adoption of a relatively smaller diameter porcelain, which is now standardised for use with 275kV cables. In the Pirelli-General oil-filled cable the equivalent heating effect is obtained by using brass for the stranded conductor.

* This kind of joint was described in the paper "An Assessment of the Impregnated Pressure Cable," by Dr. Brazier, Mr. Hollingsworth and Dr. Williams, The Institution of Electrical Engineers, April 1953.

Acknowledgment

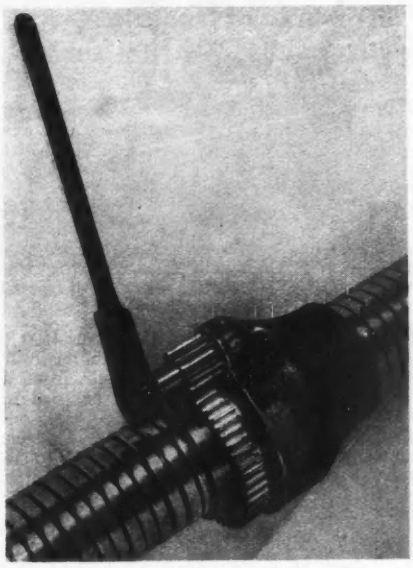
The design and experimental work involved in the development of the plant and equipment for the Supergrid was the result of close co-operation between the British Electricity Authority, the consulting engineers, Messrs. Merz and McLellan and Messrs. Kennedy and Donkin, and a number of British manufacturers. A list of the principal manufacturing firms and contractors responsible for supplying and erecting plant and equipment for the Supergrid is appended.

Main Contractors

Switching and transforming station plant and equipment : Bruce Peebles, Ltd.; The British Thomson-Houston Company, Ltd.; Crompton Parkinson, Ltd. (British Electric Transformer Company) ; The English Electric Company, Ltd.; Ferguson Pailin, Ltd.; Ferranti, Ltd.; The General Electric Company, Ltd.; Hackbridge and Hewittic Company, Ltd.; Metropolitan-Vickers Electrical Company, Ltd.; C. A. Parsons and Co., Ltd., and A. Reyrolle and Co., Ltd. Overhead line construction : Balfour Beatty and Co., Ltd.; British Insulated Callender's Construction Company, Ltd.; J. L. Eve Construction Company, Ltd.; W. T. Henley's Telegraph Works Company, Ltd., and Watsham's, Ltd.

A Geared Pipe Union

A union which replaces with a gear the normal hexagon flats, lugs or slots used for pipe joints, is illustrated below. It is made by Geartight Unions, Ltd., 94, South Street, Enfield, Middlesex. The union consists basically of a gear and pinion, the gear being formed on the nut of the union. The tightening key which embodies the pinion is located into mesh with the nut gear by seating the stem of the pinion in a hole in the body of the fitting. Amongst the advantages claimed for this union is the closer grouping of pipes which becomes possible and the location of joints in confined spaces or bulkheads.



Union with Ratchet Tightener

The tightening load is applied around the full circumference instead of in one plane, as with conventional unions, and rotation of the nut does not cause the pipeline to twist. It has the advantage also of being quicker in operation.

Any design of seating and form of thread can be incorporated into the union, and the same key is common in a range of sizes, a variety of which can be used according to particular demands, for instance, ball-jointed key, the ratchet key and in the case of large unions a motor-driven key can be applied.

Other variations of the union are available, which include shrouded unions with a protected gear and unions with three keyhole stations for use where pipes may lie in awkward locations.

Railway Vehicle Re-Railing Equipment

An equipment for re-railing locomotives and rolling stock which has been in use on German railways was acquired a few months ago for test purposes by British Railways. As a matter of interest we give in the following article particulars of the design and use of some of this equipment which makes use of specially designed hydraulic jacks, skids, beams, &c.

A FEW months ago it was announced that a re-railing equipment for rolling stock made by a German firm was to be tried out on British Railways. This equipment has been in use for some time on German railways and is made by Maschinenfabrik Deutschland Aktiengesellschaft, of Dortmund, which is represented in this country by Feska Industrial Equipments, Ltd., 27, Percy Street, London, W.1.

The equipment consists essentially of an air-operated hydraulic pump, a number of hydraulic jacks of special design and various forms of skids, platforms, beams, chains, &c. The pump unit is shown in one of the illustrations on this page. It comprises a double-acting air cylinder having a piston-rod extending through the cover at each end. The extension of each piston-rod forms the ram in a hydraulic pump cylinder which is assembled to form an integral part of the air cylinder cover. The area of the piston in the air cylinder is considerably greater than that of each of the hydraulic rams, so that the pump is in effect an intensifier which can supply

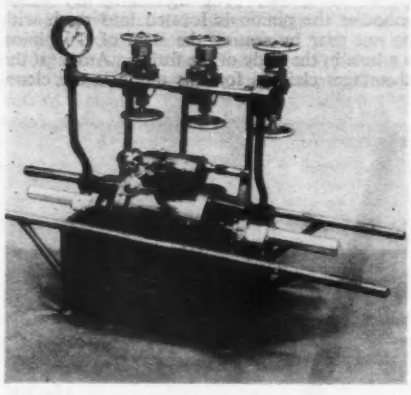


Fig. 1—Hydraulic Pump Unit

hydraulic fluid at pressures of up to some 4500 lb per square inch when working with relatively low air pressures. Compressed air from a normal train braking system can be used to drive the pump which is designed to use reasonably clean water from any quickly available source. The pressure fluid is supplied to an integral manifold on the pump set and a series of valves on this manifold can be coupled to the jacks by means of high pressure flexible hose supplied in lengths of 16ft and 32ft. Each jack is fitted with a non-return valve in its base to ensure that it will not retract and release its load should its hydraulic supply line fail. For use where no supply of compressed air is available a diesel engine driven hydraulic pumping set is made.

The jacks are made in a number of sizes, capacities and types which can be selected in accordance with the type and weight of the vehicle to be raised, its design and the conditions of working. Generally the hydraulic jacks are designed to give a very high lift in relation to their low overall height. For example a jack of 75/150 tons capacity 17in high gives a lift of about 19in and a 20/40 tons capacity jack 20in high gives a lift of some 27in.

Many forms of righting and re-railing equipment are made for use with this system and as a matter of particular interest some of those used are shown in operation in the photographs we reproduce on this page. The equipments can, of course, be equally well used for locomotives, carriages and wagon stock re-railing purposes.

The equipment shown in Fig. 2 is used in the case of a locomotive having its front coupled axle derailed. It consists of a jack mounted on a wheeled carriage which is placed on a heavy platform plate, supported by timbers on the sleepers under the front buffer beam. When this jack has raised the front of the locomotive until the coupled wheel flange is above the level of the rails a 10-ton jack is clipped, by means of yokes, on to one rail. This jack is then extended to contact the wheel rim and push the axle over until it is aligned and the wheels can be lowered on to the rails. In the case of a locomotive with several axles derailed up to a maximum distance of 2ft, the unit used consists of a heavy jack with a flat base, supported on a roller grid on the platform plate between the rail tracks. The platform plate has recesses formed in its ends, and when the locomotive has been raised by the hydraulic jack a 10-ton pushing jack is fixed in the recess at one end. This small jack is extended to press on the base of the main jack and push it, together with its load, along the roller grid until the locomotive wheels register over the rails when it can be lowered.

When there is a bad derailment and a locomotive or vehicle is some distance from the track, rail bridges such as that illustrated in use in Fig. 3 are used. These bridges are made in various lengths up to 16ft, and they are built up of two parallel rails rigidly bolted together with spacer blocks between. The bridge forms a track for a hydraulic jack mounted on a carriage fitted with double flanged wheels. At one end of the bridge is a 10-ton capacity hydraulic pulling cylinder carrying a chain claw. The bridge is placed in position across the rails with one end protruding out beneath the vehicle this end being supported on heavy packing

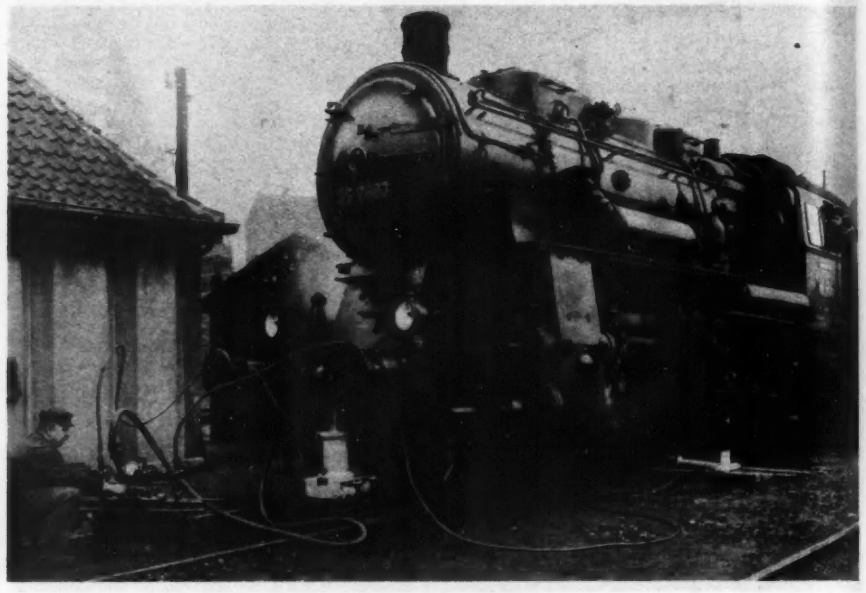


Fig. 2—Locomotive Re-Railing Unit

Fig. 3—Re-Railing Bridge Equipment

blocks to bring it to the same height as the rails. When the hydraulic jack has been extended to raise the vehicle until its wheels are above rail height, the jack carriage is connected by means of a chain to the claw of the pulling cylinder at the inner end of the bridge. By means of this chain operated by the pulling jack, the jack-supported vehicle is hauled into position above the rails. Various combinations of bridges and jacks can be used to re-rail locomotives and vehicles in accordance with the distance they are from the tracks and the conditions at the time.

Other jacks used include a 40 tons capacity "claw" unit with its lifting head set at the bottom of the jack piston and only some 3½in above base level. This jack has a lift of over 30in and can be used to raise a vehicle to an operational level when it has sunk deep in the ballast or ground at the side of the track. For pulling vehicles along the track, and similar operations, a hydraulic hauling device with a capacity of 30 tons and a stroke of 31in is supplied complete with blocks and cables.

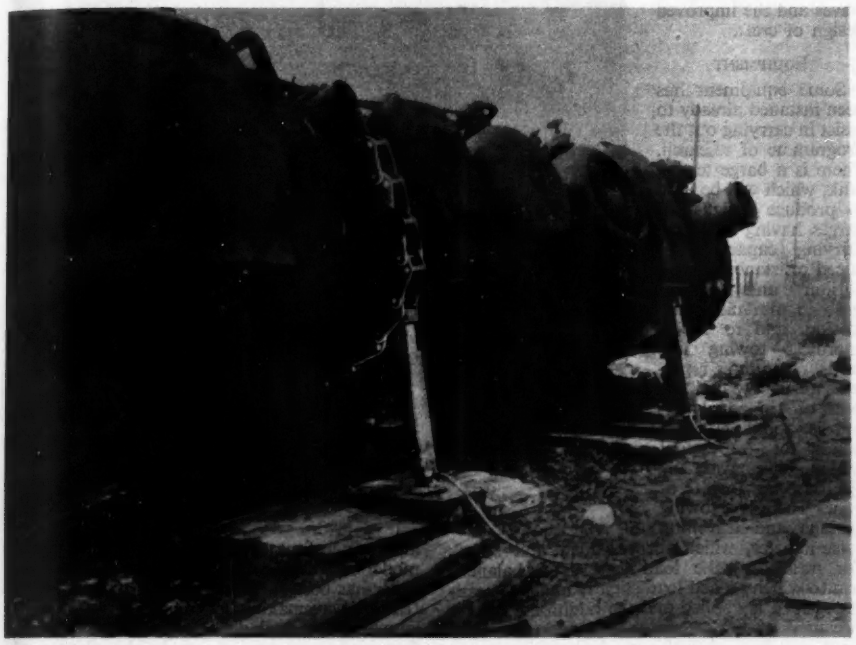


Fig. 4—Equipment for Righting Locomotives

The special jacking and other equipment used for righting derailed and overturned locomotives can be seen in Fig. 4. The locomotive is first raised to a position in which special chains can be passed round it. This initial lifting is done by means of two claw jacks. With the jacks firmly seated on timber planks a double rail is placed between the claws and under the steam dome of the engine. The jacks are then extended until an ordinary telescopic jack can be inserted. When this jack has been extended to its limit the locomotive will be at such an angle that its ends can be propped with safety. Two heavy pin chains are then slung partly round the boiler near its extremities and rigidly fixed in position by steel cables which are tensioned by means of turnbuckles. Two hydraulic jacks mounted on rocker cradle bases and having special heads which locate in the chains on the pins are then inserted as shown. These jacks are extended to their limit and if by that time the locomotive has not been raised to an angle sufficient for it to right itself, two jacks are inserted below to supply a further lifting movement through the chain. If a second set of pin jacks is not available, the pulling device described previously can be anchored to an adjacent track or suitable point and its cable attached to an upper part of the locomotive boiler. When a locomotive has been raised to an angle of 40 to 45 deg. this pulling device has been found sufficient to continue the righting movement till the point is reached at which it tips back on to its wheels.

Fire Resisting Cables

We have received some particulars of a new range of asbestos-paper-tape-insulated cables developed by Pirelli-General Cable Works, Ltd., a subsidiary of the General Electric Company, Ltd., Magnet House, Kingsway, W.C.2. These cables* are intended for use in circuits up to 660V in situations where fire resistance, non-inflammability, maintenance of electrical properties under elevated temperatures, and non-ageing properties are required.

Copper conductors, which may be single or stranded, are lapped with a special quality asbestos paper tape. The cores are laid up, asbestos paper taped, and sheathed with a welded aluminium sheath ("Asbestal") or, alternatively, with a welded stainless steel sheath ("Asbesteel"). The smaller "Asbestal" cables have a cold-welded aluminium sheath with a small longitudinal fin, while the larger "Asbestal" cables have a corrugated argon-arc welded aluminium sheath, which has the advantage of flexibility similar to that of a lead sheathed cable, combined with sufficient stiffness in relation to weight to enable the distance between supports to be considerably greater than that necessary with lead sheathed cable. The corrugations also increase the resistance of the sheath to mechanical damage.

The multi-core cables are designed to have a constant insulation thickness between conductors, with a variable thickness between conductors and sheath. The conductor insulation thickness varies very little from 0·05in, but owing to the limited number of sheath diameters, considerably more than 0·05in thickness between conductors and sheath is used in many cases. Single-core cables have all to be insulated to fit the nearest standard sheath and considerable variation above a 0·05in minimum consequently occurs. The asbestos-paper tape employed has a high degree of resistance to moisture absorption and to destruction by fire.

The insulant is stated to be indestructible for all practical purposes and the cable itself will continue to function at temperatures up to the melting point of the sheath. Since the insulant is dry, the cables are non-bleeding and are therefore very suitable for vertical runs which may be subject to overload or high temperatures.

The corrosion resistance of "Asbestal" is similar to that of other kinds of aluminium sheathed cable and is in general not very different from that of lead covered cable. Where the cable is to be drawn through ducts, laid direct in the ground, or installed in corrosive atmospheres, suitable additional protective covering is recommended. Normally the covering is compounded, P.V.C. double taped, compounded, lapped with two compounded glass staple tissue tapes and compounded hessian taped overall.

"Asbesteel" cable has advantages where increased strength and resistance to mechanical damage are required. The stainless steel sheath has good corrosion resisting properties which make it particularly suitable for use in chemica and rayon factories.

The minimum bending radius in installation for both "Asbestal" and "Asbesteel" cables should be twelve times the overall diameter. These cables can be handled by normal methods during installation, although the cold-welded aluminium sheath cable and the stainless steel sheath cable are somewhat less flexible than a corresponding lead covered cable. A bending tool is available for use when required and is recommended where accurate setting is necessary. This minimum bending radius does not apply to corrugated aluminium sheathed cables. The installation technique for both types of aluminium sheathed cables is generally similar to that for other aluminium sheathed cables. Non-plumbing glands are available. They are threaded to suit standard conduit boxes and fittings and are provided with nuts for fitting to boxes with plain entries.

"Asbestal" cables are available in most normal sizes between 1/·044 and 37/·103 (single-core), between 1/·044 and 19/·072 (twin-core), between 1/·044 and 19/·064 (three-core), between 1/·044 and 19/·052 (four-core) and between 1/·044 and 19/·044 (seven-core). "Asbesteel" cables are available in most normal sizes between 7/·036 and 37/·083 (single-core), between 3/·029 and 19/·052 (twin-core), between 3/·029 and 19/·052 (three-core), between 1/·044 and 19/·052 (four-core) and between 1/·044 and 7/·052 (seven core).

* British Patent No. 661540

Conductor Stringing with the Help of Rockets

We learn that coastguards' rocket equipment was used recently to shoot a light rope across the Aber Gorge, near Bangor in North Wales, to act as a draw-line for conductor stringing on a 132kV overhead line. The gorge is a valley approximately 1 mile wide at the crossing point and almost 600ft deep, with steeply sloping sides and, as the area is a national park, great care had to be taken to minimise any possible damage to trees and shrubs. The section over the gorge is part of the 55-mile long Queensferry-Dolgarrog-Bangor line which is being erected by British Insulated Callender's Construction Company, Ltd., for the Merseyside and North Wales Division of the British Electricity Authority.

Three towers were erected, one at the top of each side of the gorge and a third on a spur almost in the centre of the valley. Work on erecting the first span started early this month when local representatives from the coastguard service brought their rocket equipment (which is similar to that used at sea to erect a breeches buoy) to the tower on the spur in the valley.

The rocket with a rope attached was fired a distance of 1425ft towards the tower on the east side of the gorge. The end of the rope near this tower was attached to a balloon winch, while the other end was secured to the conductor which was wound on drums near the middle tower. The steel-cored aluminium conductors were then hauled across and erected, the entire span being 1800ft.

The procedure for erecting the second span—a distance of 2400ft between the middle tower and the tower on the west side of the gorge—was partially reversed. The rocket was fired 1800ft from the top to the middle. The drums of conductor and earth wire were placed at the top tower and the balloon winch, still in its original position on the east side, was utilised to draw them into place. The second span will be finally erected this week-end. Both spans consisted of three S.C.A. conductors, each comprising 30/·110 aluminium and 7/·110 steel and a similar earth wire.

Hydraulic Research Laboratory

IN 1950 the Docks and Inland Waterways Executive established a research department for the purpose of investigating both hydraulic and marine engineering questions concerned with a variety of subjects related to the design and operation of water transport and the economic and efficient maintenance of properties and assets. For this purpose a new research station has been built for the Executive to resolve problems not hitherto covered by existing research establishments of the British Transport Commission.

The new station was officially opened by Lord Hurcomb, the chairman of the British Transport Commission, who, in a short speech, said that the station made available facilities for specialised research which had not existed previously. He mentioned that some activities within the Commission's undertaking were much older than the railways and that the Executive controlled 100 miles of quays and 1750 miles of inland waterways, a responsibility which pointed the need for scientific research. The research department linked up with existing establishments and effected liaison with other organisations such as the Hydraulics Research Station at Wallingford and the Hydraulics Section of the National Physical Laboratory. Much useful information had been gathered for the benefit of several departments by the research section, but, Lord Hurcomb said, it was found that many problems could only be solved by new investigations, and these would be taken care of in the new laboratory.

Some of the immediate problems, he continued, concerned the design of improved lock gates, sluices, waterway embankments and craft, the investigation of corrosion problems and the study of methods of protecting timber structures from the attacks of marine borers. Another group of problems was related to the behaviour and physical characteristics of water with reference to harbours, rivers, canals and docks. Apart from the immediate present, Lord Hurcomb thought that a stage had been reached where long-term investigations could be undertaken, and felt sure that the future of the transport undertaking depended upon a forward policy of scientific research and development.

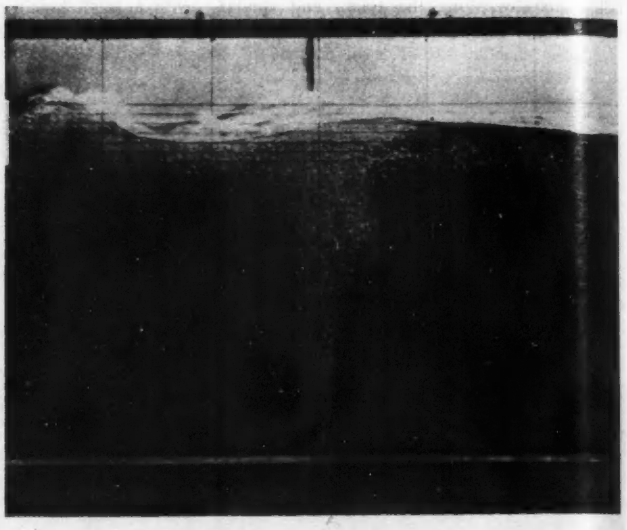
Following the official opening, we were able to make an inspection of the single-storey building, which is 126ft long by 45ft wide, and has load-bearing brick walls and north-light roof trusses carried internally on steel girders and stanchions. An illustration shows an interior view of the laboratory with the barge testing tank to the right, the wave tank in the background and the hydraulic waterway model in the foreground.

Many problems are waiting to be solved and experimental work will be undertaken in the laboratory in connection with the improvement of works associated with flowing waters in rivers, canals, docks and harbours, and the prevention of scour. Other matters to be studied are the quicker filling of locks and docks without turbulence, improved methods of lock operation and the elimination of cross currents, while a study of the energy in the wash from various craft and its effect on banks will be included in the programme. Other research work which is already in hand concerns the damping of waves and the improved design of craft.

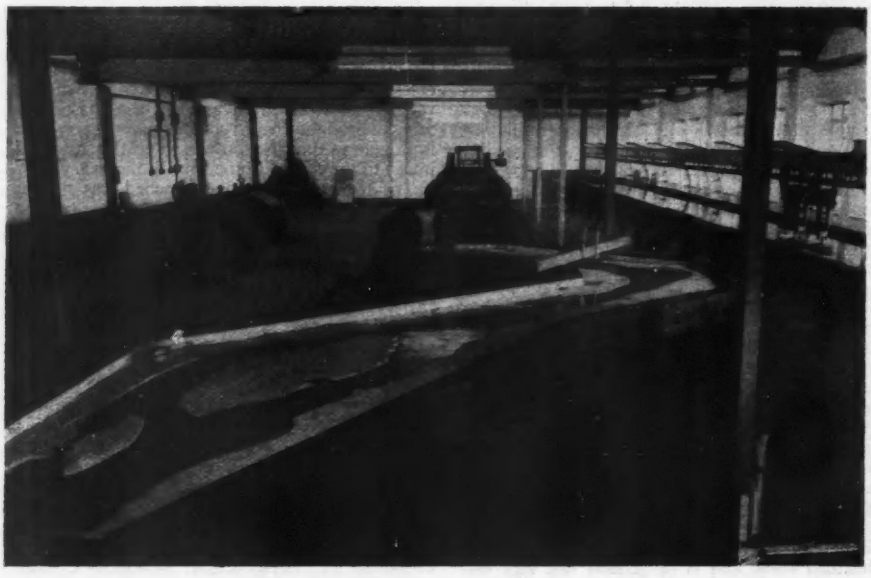
Equipment

Some equipment has been installed already to assist in carrying out the programme of research. There is a barge testing tank, which will be used to produce designs for barges having increased carrying capacity, reduced resistance to propulsion and smaller wash to minimise bank erosion, and to evolve improved towing methods. The tank represents a narrow canal to a scale of 1in equals 1ft and is about 110ft in length, of trapezoidal section, 48in wide by 4½in deep for a width of 18in. There is a towing carriage and travelling dynamometer, which records load and speed. For measuring the load there is a balanced arm to which a dead load slightly under the estimated load is applied and the additional load is measured by the extension of a spring and the movement of a vertical arm, the arm movement being magnified by three to one and recorded by a stylus. A micro-switch marks off every 10ft of travel of the carriage and a clock makes and breaks an electrical circuit at half-second intervals, so that the speed can be calculated. Records are taken over a fixed length of 60ft over the midlength of the tank, so as to avoid any effect of a pressure wave from the end of the tank, and the wave formation may be observed through a glass panel in the tank side.

The temporary calming of waves would greatly facilitate the repair of works exposed to the sea and since fixed or floating breakwaters are not always a practical proposition in the approaches to dock and harbour entrances, the pneumatic breakwater method is being investigated in a wavemaking tank. This method, which consists of calming the waves by means of air from pipes on the dock bottom, rising in bubbles, was employed during repairs to the Dover train ferry dock gates in 1952 with some degree of success, when four pipes were used and air at about 50 lb per square inch pressure was released at a rate of 15 cubic feet of air per minute per foot of pipe. In the wave tank a model of a dock entrance and pneumatic breakwater has been prepared in a scale of 1in equals 1ft. A wavemaking machine creates waves of known height and distance between crests and then air is released, as seen in the photograph reproduced herewith, from two lines of pipes, on the bottom of the tank, at the rate of 2 cubic feet per minute per foot of pipe, and the reduction in the height of the waves noted. Early results of the experiments indicate that the length of the wave is the more important factor, a tank wave representing a wave 40ft long by 4ft 3in being damped down to 29 per cent of its height, while a wave of the same height, but 115ft in length, was only damped down to 53 per cent of its height, while a wave measuring approximately 179ft by 2ft 4in was damped down to 72 per cent of its height.



Wave Tank Showing Pneumatic Breakwater



Interior of Laboratory

To investigate the causes of excessive silting over a particular section of the River Severn at Bevere lock a hydraulic model of the waterway has been built to a horizontal scale of 44ft equals 1 mile and a vertical scale of 1in equals 3½ft. Water levels in different parts of the model and the height across the weir at different discharge rates represent actual conditions, and preliminary experiments are in progress to ensure that the rates of silt deposit correspond with those of the river.

Another model seen in the laboratory was that built to investigate a cooling water problem. This concerned the operation of a proposed power station which might raise the temperature of the waters of the River Calder and of the Aire and Calder canal and make them too warm for use as cooling water for existing power stations downstream. The thermo-hydraulic model represents about a mile of the river to a horizontal scale of 36ft equals 1 mile, a transverse scale of 1in equals 10ft, and a vertical scale of 1in equals 2ft.

An extension of the method often employed for effecting dock quoin repairs has resulted in the design of a limpet dam for the repair of dock

sills without closing the dock to shipping. A model was on view accompanied by drawings of the limpet dam constructed for the Regent's Canal ship lock. The shell was of 0·25in thick plating, rolled to a radius of approximately 4ft, to form a half circle and stiffened by 3in by ¼in. flat bar transverse frames spaced about 2ft 6in apart and three longitudinal stiffeners of 3in by ¼in flat bar. The seals which rest on the dock bottom consist of a length of hardwood timber faced with soft wood, clay packing in hessian bags and a rubber flap. After placing the vertical sections in position at the quoins and pumping them out, the limpet dam is lowered into place, connected up to the vertical sections and then pumped out, after which a portable diaphragm at the bottom of the quoin sections is removed to give access to the limpet dam, which is held in place by hydraulic pressure. With the dam in place repair work to the sill can be carried out without stopping the movement of shipping except for a restriction on draught.

A Radio-Frequency Edge-Gluing Machine

TWO years ago the G.E.C.-Fielding 5kW radio-frequency edge-gluing machine was first produced. It extended the application of r.f. heating to the manufacture of block board or panels by edge gluing strips of wood. Hitherto the main applications had been in jointing (as in furniture manufacture), and the production of plywood, curved laminated sections and materials from waste wood. Recently Fielding and Platt, Ltd., and The General Electric Company, Ltd., have enlarged the range of r.f. edge-gluing machines to include a 25kW model, which speeds the operation to give at least three times the output. Like the 5kW machine the 25kW model is a complete unit, as illustrated here. It comprises a pneumatically operated press, with feed table and automatic loader, to which optimum r.f. power is applied through a variable load-matching unit from a G.E.C. 25kW radio-frequency generator.

A 25kW Radio-Frequency Edge-Gluing Machine

The machine has been designed for the production from wood strips (after the glue has been applied in a glue spreader) of boards of the following dimensions : length 36in to 80in, width up to 40in, and thickness ¾in to 2in (finished size). In any board the stock must be of uniform thickness, but need not be cut accurately to length before treatment. Boards of any width up to the maximum can be produced by using packing pieces of the same thickness as the stock being glued. The wood strips may be of any convenient width and single boards can be made up of strips of different widths.

Production rates of 6000 square inches of glue line set hard in three minutes can be achieved, the actual rate depending to some extent on the nature of the wood and the kind of synthetic glue used. This means, for example, that boards of the maximum dimensions, 80in by 40in by 2in, made up from wood strips 1in wide, can be glued in about three minutes. Because of the selective heating of the glue, the panels themselves remain comparatively cool and can be handled as they leave the press immediately ready for the next production process. The necessity for expensive tongued and grooved joints between strips is entirely eliminated.

Operation of the machine has been made as simple as possible. The entire process is controlled by two operators, one assembling panels on the table and the other feeding the glue spreader and stacking completed panels. Once a panel has been assembled on the feed table the remainder of the cycle is carried through automatically in the correct sequence by pressing a single push button. To start the machine the operator switches on the mains switch on the front of the r.f. generator and presses the compressor motor push-button switch on the main control panel. After a delay of about two minutes the generator is ready to deliver power and the requisite pressure is established in the air reservoir. The operator next receives stock from the glue spreader and assembles it on the feed table which, having a stainless steel top and stops along two edges, serves as the lay-up table. The operator then presses the "start" push button and a pneumatically operated loading arm pushes the assembled stock direct into the press. As a precautionary measure the "start" button is inoperative if pressed before the previous cycle has been completed. The remainder of the cycle is fully automatic and the operator is able to assemble the next panel whilst it is in progress.

The sequence of the automatic operation is as follows : the loading arm, having moved the panel into the press, returns to its normal position ; vertical pressure is applied to the panel in the press. Then, after a short delay, side pressure is applied. Next the radio-frequency power is applied and the heating cycle begins ; during the heating cycle red signal lamps are alight.

At the end of the heating cycle the radio-frequency power is switched off, side pressure is removed and, finally, the vertical pressure is released. The glued board is ejected when the loading arm moves the next assembly into the press.

The Press and Feed Table

The feed table at the ingoing end of the press has a stainless steel top mounted at a height of 2ft 9in to allow the stock to be fed direct into the press. The table has a raised stop along both edges, and either stop, together with the face of the loading arm can be used as a jig against which the panel of glued stock may be assembled. The loading arm, normally positioned at the end of the feed table, is pneumatically operated to move the assembled stock into the press.

The press platens are of stainless steel and are used as electrodes to apply the radio-frequency power to the charge. The top (or electrically "live") platen is fixed, vertical pressure being applied through the lower (or electrically "earthed") platen.

The whole press space is totally enclosed in a metal casing to prevent the operator coming into accidental contact with the "live" electrode. The stock enters and leaves the press through spring-loaded flaps, which are arranged to switch off the r.f. power automatically if they are opened during the heating cycle. The same switches prevent the application of pressure whilst the flaps are open. A self-contained electrically driven compressor, rated to give one complete cycle every forty-five seconds, is fitted to the unit. Vertical pressure up to 10 lb per square inch is applied through eight cylinders working on the lower platen. Six cylinders are used to apply a variable side pressure up to 160 lb per square inch. The cylinders have a stroke of 4in. The operator's controls are fitted on the special load matching unit in a convenient position. They include a push button to start the compressor motor, "stop" and "start" push buttons to control the automatic sequence of operations, a power output meter and signal lights to show the state of operation. The dimensions of the feed table and press are : overall length 16ft 6in, width 6ft 2in, height 4ft and the feed table working space is 7ft 6in by 3ft 4in.

Radio-Frequency Generator

The push-pull oscillatory circuit uses two "Osram" ACT16 valves. The power supply is taken from a three-phase, full-wave rectifier employing six "Osram" GU21 rectifier valves. Separate transformers supply the oscillator valve filaments, rectifier filaments and a 240V operating supply. A voltage stabiliser in the oscillator valve filament supply prevents premature failure of the valves due to mains fluctuations. The circuit is protected by overload relays, airflow relay, a time relay for rectifier valve protection, mains and auxiliary fuses, and special rectifier valve anode fuses. A radio-frequency filter unit is fitted to eliminate r.f. leakage back into the mains.

Two oscillator valve anode current meters and two grid current meters are mounted on the front panel of the generator. An hour meter is fitted internally. Safety switches are fitted to the doors and removable panels of the r.f. generator to prevent operation of the generator when not secured in position. The generator carries a green lamp to indicate "Mains On," a blue lamp to show the end of the time delay and that all safety gate switches are closed, and a red lamp to indicate that the generator is in full operation. The oscillator valves and general interior of the set are cooled by a filtered air blast from a self-contained fan.

The St. Lawrence Seaway

(By Our American Correspondent)

EVERY American Administration since that of the late President Harding has supported the scheme for a St. Lawrence seaway to bring ocean-going shipping into the Great Lakes. The Truman Administration pressed hard for the construction of the seaway in co-operation with Canada, coupled with a joint development of the power resources of the St. Lawrence River. But the project has always been blocked by powerful interests which fear competition including the railways, the coastal port cities and the power companies. They attack the seaway as a "socialised ditch" and the power generating scheme as a "New England T.V.A." In the face of American inaction, Canada, some time ago, proposed to build the seaway alone. At last, only the formal approval by the U.S. Federal Power Commission of an examiner's report, recommending the designation of the New York State Power Authority as the American agency to develop the hydro-electric potential of the International Rapids Section of the St. Lawrence River, is needed now to permit a start on the physical construction of the long-discussed St. Lawrence Seaway and Power Project. A few days before the examiner, Mr. Glen R. Law, made his recommendation, President Eisenhower's full Cabinet had given its unanimous approval to a limited United States participation with Canada in the development of the seaway itself, as distinct from the power project. The construction of the hydro-electric works, which now awaits action by the Federal Power Commission, is, however, a necessary preliminary to the building of the seaway. As now planned, the seaway differs somewhat from earlier concepts. Instead of extending from the Atlantic Ocean to Duluth, Minnesota, at the far end of Lake Superior, the channel would end at Toledo, Ohio, at the western end of Lake Erie. Furthermore, minor changes in the channel route through the St. Lawrence River section may be occasioned by the enactment or defeat of a Bill sponsored by Senator Alexander Wiley, which is now pending in the Senate and, apparently, has been approved by President Eisenhower. If enacted, this measure would provide an American contribution of about 100 million dollars to the cost of the seaway phase of the dual scheme, with the ship canal running through the International Rapids on the United States rather than on the Canadian side. If it fails, Canada has declared that she is ready to go ahead with an all-Canadian seaway development which would put the channel on the Canadian side of the International Rapids.

Since the end of the last war both the United States and Canadian Governments have been subjected to heavy industrial pressure to start the construction of the scheme. A major factor in this respect has been the depletion of iron ore deposits in the Mesabi Range beyond Lake Superior and the discovery of huge new deposits in Labrador. With a booming industrial economy, Canada wants to bring Labrador ores from Seven Islands* north of Quebec, through the St. Lawrence, Lake Ontario and Lake Erie to its important industrial centre near Windsor, opposite Detroit. Similarly, American iron and steel interests in Cleveland, Toledo, Detroit and elsewhere are anxious to obtain Labrador ores for their blast-furnaces. An increasing Canadian and American need for electric power has similarly contributed to the pressure. According to current official estimates, 12,000,000,000kWh of hydro-electric power can be obtained yearly by utilising the water flow in the International Rapids section of the St. Lawrence. This is an area roughly 48 miles long, where the river forms the international boundary between the two nations. As now planned, half of this hydro-electric potential would go to the New York State Power Authority and half to the Province of Ontario. New York's share of this output would be equivalent to one-sixth of the present power production of the State, and should make possible a 60,000,000 dollar cut in the bills of electricity users because of its low production costs. The nearness of an actual start of constructing the seaway has intensified, rather than lessened, the opposition of railway, shipping and port interests in the United States to the seaway. It is being argued that the seaway will deprive the railways of freight they otherwise would carry, that it will take commerce away from New York, Baltimore, Philadelphia, New Orleans, and other ports and give foreign shipping a considerable advantage over the American merchant navy. Because the minimum channel depth of the seaway will be only 27ft., it has been maintained that the bulk of American ocean-going shipping will be barred, as it requires a depth of 27ft 6in in salt water or 29ft in fresh water. Shallow-draught Great Lakes ore carriers could negotiate the seaway, but they are not suitable, generally, for trans-oceanic voyages. British, French, Norwegian, Dutch and Greek vessels, which average 8000 tons, fully loaded, would therefore enjoy a monopoly of the seaway business, according to certain American shipping interests.

Fortunately, these objections, which prevented the Congressional approval of a joint American-Canadian development of the seaway in the past, are no longer dominant. Thanks to the overwhelming need for increased electric power generation and for obtaining access by water to the Labrador iron ores, there is now every reason to believe that the seaway will be built in spite of the objections raised by certain interests. The recommendation that the New York State Power Authority be designated as the American agency to develop the hydro-electric power, if approved by the full Federal Power Commission, would resolve the long dispute over Federal versus State rights to St. Lawrence electric power that brought many acrimonious exchanges between Governor Dewey of New York State and the former Presidents Truman and Roosevelt. Even before the Commission has taken final action, however, a political dispute over the distribution of the State's share of the power has arisen. The Democratic party in New York State already is accusing the Republican Dewey State Administration of planning to turn the electric power over to private utility interests for distribution and sale. Instead, the Democrats want the State to build its own transmission lines to carry the power to load centres, where municipalities and co-operatives could distribute it to consumers by systems publicly or co-operatively owned. This issue may well become an important factor in the State Government election campaign next year; but, it is hoped, it should not seriously interfere with the go-ahead being given at last to the basic St. Lawrence Seaway scheme.

* See "The Engineer" March 13, 1953, page 399

American Engineering News

(By Our American Correspondent)

Hot Extrusion of Alloy Steel Tubes and Shapes

The hot extrusion by the Ugine-Sejournet glass lubricant process of alloy steel tubing and shapes is now taking place at the works of the National Tube Division, United States Steel Corporation, at Gary, Indiana. The installation comprises a 2250-ton "Loewy" hydraulic extrusion press which is capable of producing seamless tubing of 1¼in to 6¼in O.D. With the existing tooling, the maximum size which has been extruded so far is 5¼in O.D. The annual capacity of the installation will depend on the weight of the billets charged and the product being extruded, but at full production and with a favourable product schedule, it is estimated that the press will turn out some 2000 tons a month. With the aid of this new facility, the Gary works can now produce tubing from non-pierceable grades of stainless steel, and can

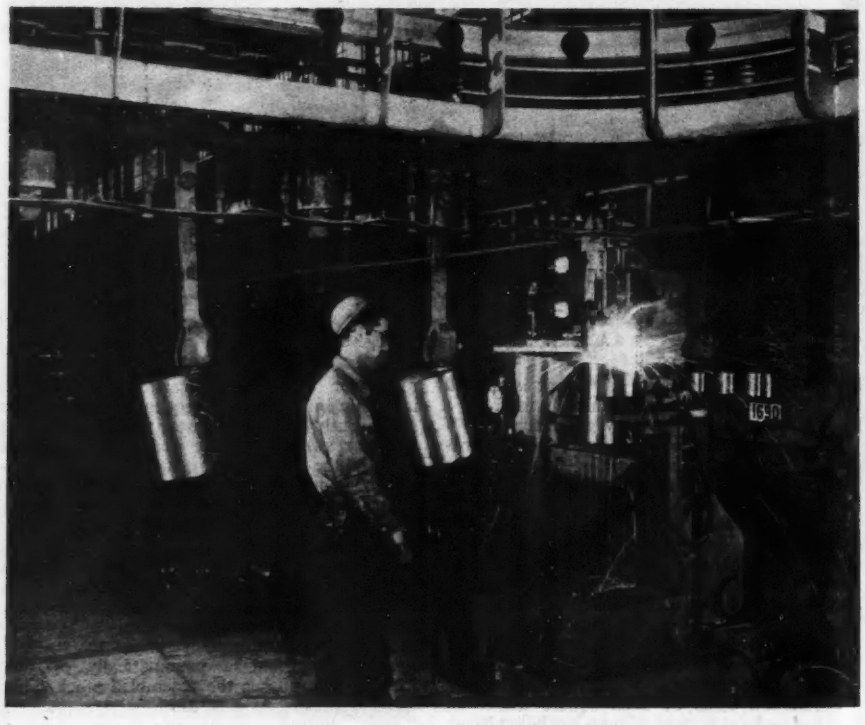


Fig. 1—Welding of Studs to Extrusion Slugs

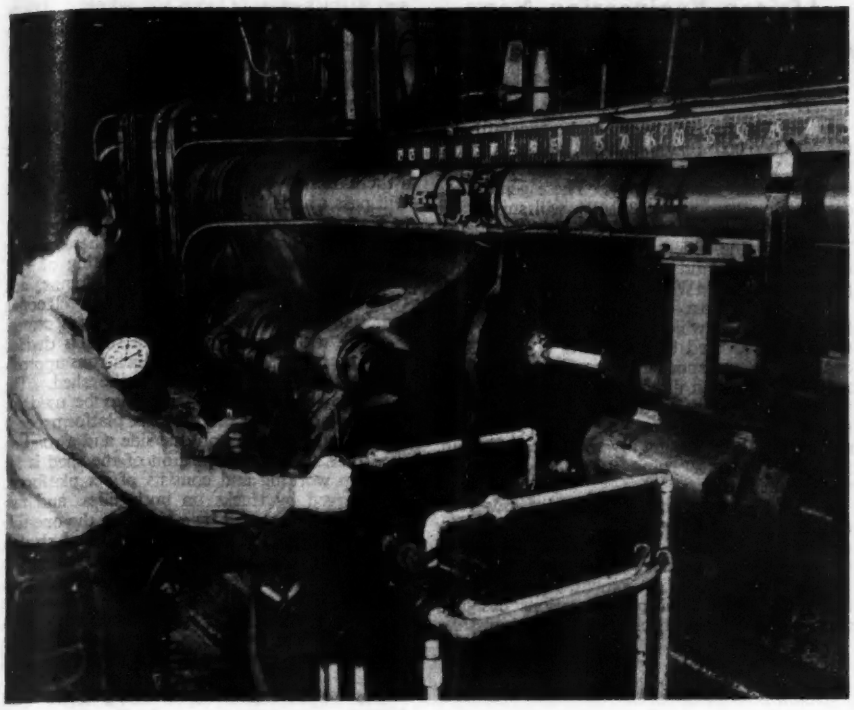


Fig. 2—Mandrel Advancing Towards Extrusion Slug

also extrude unusual shapes which cannot be rolled because of their unbalanced design.

The steel billets required for the process are supplied by other mills of the company and arrive in the form of rough-turned and surface-conditioned rounds. These rounds are cut into extrusion slugs by circular saws, and, after cutting, the slugs are weighed and, in some cases, the leading end is chamfered. For the production of small diameter tubing of stainless steel the slugs are drilled. To facilitate the handling of the slugs by overhead conveyors, a specially headed flux-filled stud is welded to the end of each slug by a semi-automatic electric-arc welding process (Fig. 1). Cast alloy steel hangers, which have been designed to withstand severe and repeated thermal shocks, are suspended from an overhead conveyor, and the stud is engaged by a slot in the hanger, thus enabling the suspended slug to be moved into the heating furnace. The plant employs a three-zone, gas-heated furnace with a slotted roof to permit the passage of the necks of the hangers. The furnace can produce maximum temperatures of 2400 deg. Fah. From the furnace, the conveyor carries the slug to a barium chloride bath, in which temperatures up to 2300 deg. Fah. may be maintained. The extruding temperatures required vary with the analysis of stainless steel being used, but the average temperature is 2250 deg. Fah. The slugs are heated in the gas furnace almost to the final extrusion temperature before being transferred to the salt bath. The salt bath completes the heating of the slug, coats the billet and reduces any surface scale which has formed. After leaving the barium chloride pot, the heated slug is conveyed to a charging bogie. Here the welded stud is severed with an air-driven chisel. The slug drops on to the press charging bogie, which positions the billet in the press. A sheet of fibre-glass is placed on the table and wraps around the slug as it rolls into position in front of the extrusion press.

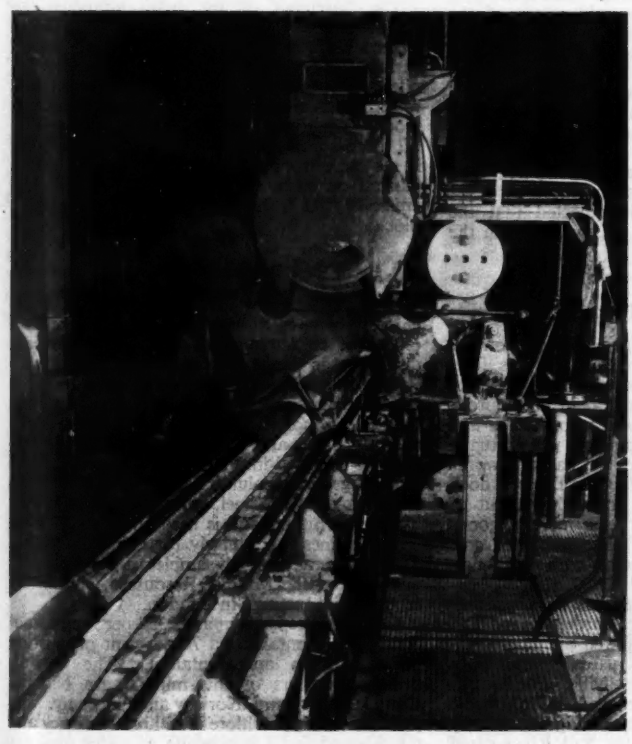


Fig. 3—Extruded Product on Outlet Conveyor

The press itself is prepared in advance for each extrusion by placing the appropriate die in position and packing the slug case with sandwiches of various thicknesses of woven, pane, spun or other forms of glass, depending on the extrusion shape and the composition of the steel. The face of the ram is protected by a removable steel dummy block. In extruding tubes, a mandrel (Fig. 2), which projects through and beyond the ram, is covered with a fibre-glass stocking. In some cases it is possible to use the mandrel as a piercing tool, eliminating the need for drilling the slugs beforehand. This practice is limited to large-diameter tubes because of the structural strength limitations of the mandrel. A special air cylinder on the charging bogie inserts the prepared slug into a heavy, circular steel container. A spacer piece is lowered before the face of the container, the ram is advanced and pressure is applied. The head and pressure reduce the glass to a viscous liquid, which serves as a lubricant as the steel is forced through the die. The main ram is powered by an 1800-ton hydraulic cylinder and the piercing mandrel by one of 450 tons, providing a total available extrusion force of 2250 tons. The power for the press and its auxiliary equipment is transmitted through a closed hydraulic system using a solution of water and soluble oil as fluid. A prefill tank of 1200 U.S. gallons and a gravity tank of 6800 U.S. gallons provide a total fluid capacity of 8000 U.S. gallons. There are two hydro-pneumatic accumulator systems, each with a maximum pressure capacity of 3900 lb per square inch, which is equivalent to 300 lb per square inch in excess of the maximum operating pressure requirement of 3600 lb per square inch. An air compressor, having a maximum capacity of 4000 lb per square inch, is provided for charging and recharging air to the accumulators.

After the slug has been extruded there remains in the container the unextruded portion, or butt. This is usually less than $\frac{1}{2}$in long. The container is moved away from the die by approximately 4in. This draws part of the extruded tube back through the die and provides space for a high-speed circular saw to cut the butt from the tubing. Subsequently, the container is advanced again to push the severed tube on to an outlet conveyor. The butt is then pressed from the container by the rammer. It falls into a chute which conveys it to an operator who removes the butt from the dummy block by a hydraulic squeezing mechanism. The butts are recovered for scrap ; the dummy blocks for re-use. The extruded product leaves the die by means of the outlet conveyor (Fig. 3). This is followed by a table from which the product can be dropped into a water-quench tank or on to an air-cooling rack. After either quenching or air cooling, the product is weighed and inspected. At present, some shapes have a tendency to twist as they leave the die. After cooling and inspection, these are moved to a stretch straightener for the elimination of any objectionable twist. Glass and oxides adhering to extruded tubes are removed by treatment in a special pickle solution. After rinsing, the tubes are ready for further processing—either cold tube reducing or cold drawing. The dies in the extrusion press become thinly glazed after each operation and must be cleaned before re-use. Thus, three dies are required for continuous operation : one in the press, one being cleaned, and one in reserve. The press container is also cleaned with a rotary brush after each extrusion.

A Non-Electrolytic Nickel Plating Process

The General American Transportation Corporation, of Chicago, Illinois, has announced the development of a chemical rather than electrolytic method of nickel plating, which has been called the " Kanigen " process. It may be recalled that some seven years ago, A. Brenner and G. Riddell, working at the National Bureau of Standards, published details of what was then considered an entirely new nickel plating process. (" Nickel Plating on Steel by Chemical Reduction," *N.B.S. Journal of Research*, Vol. 37, July, 1946, page 31.) Because the process employed an ordinary chemical reaction instead of electrolytic action, it became known as " electroless " nickel plating. Despite the saving in electrical equipment, however, the process was costly, and it was thought unlikely that the method would find any wide commercial application. With the announcement of the " Kanigen " process, interest has been renewed in " electroless " nickel plating, and although little specific data on the new process is available, the information that has been released appears to indicate that

significant improvements in the direction of greater practicality have been achieved. The chief advantages of the "electroless" nickel plate, as compared with the conventional nickel plate, can be summarised as follows:—(1) It is applicable to many parts which cannot be successfully electroplated; (2) for a given thickness, it appears to offer better corrosion protection to the base metal; (3) considerably less nickel is required to ensure a given minimum plate thickness; (4) it is more wear resistant; (5) hardness can be increased by a short heat-treatment. The main limitation is its much greater brittleness as plated.

Actually, "electroless" nickel plate is a nickel phosphorus alloy composed of 90 per cent to 95 per cent nickel. It has shown good adhesion on steel, aluminium, copper and brass, nickel, cobalt, gold, silver and palladium. Good plating cannot be obtained on tin, cadmium and zinc. It is said that variations of the thickness of the plate can easily be held within 10 per cent of the average thickness. Hence, the plater, having determined that 0·001in was the minimum desirable plate thickness on a given part, could operate his bath to produce a plate averaging 0·0011in. Such uniformity is independent of the shape of the part and extends to sharp angles, undercuts and interior surfaces. The "electroless" nickel plate is claimed to have corrosion resistance "almost equal to that of wrought nickel." Its porosity is said to be decreased by heat-treatment, but even without heat-treatment it is reported to be less than in electroplated nickel of the same thickness. The coating produced by the "electroless" process is considerably harder than an electroplated nickel coating and can be increased in hardness by proper heat-treatment. As plated from the standard "Kanigen" bath, the hardness of the coating ranges from Vickers 550 to 650, averaging 600. A coating of Vickers 600 hardness deposited by the "Kanigen" process is too brittle to be subjected to flexing in service or fabrication. A coating of Vickers 450 hardness is probably less brittle, but still is easily frangible. The coating has a coefficient of expansion of 13×10^{-6} per deg. Cent. and an electrical resistivity of 60 microhms per centimetre. As in electroplating, the appearance of "electroless" plates depends largely upon the surface finish of the base metal, and with proper control bright plates can be obtained.

A clean metal surface is just as important for satisfactory "electroless" plating as it is for electroplating. Therefore the same steps in surface preparation which are followed prior to electroplating are recommended in connection with the non-electrolytic method. The suitably prepared metal is immersed in the chemical bath which is held at a temperature near 210 deg. Fah. to accelerate the chemical reaction and to keep the rate of metal deposition as high as possible. The plating speed is further increased if the metal and the bath solution are in motion with respect to each other. The chemical reaction which takes place is essentially the reduction of a nickel salt to metallic nickel, with accompanying formation of acid. The best yield obtained by Brenner and Riddell, based on the conversion of hypophosphite to phosphite, was 37 per cent. It is understood that this yield has been improved considerably in the "Kanigen" process. The plating rate varies with the pH level of the bath. In most of the baths, now operating, the rate of metal deposition does not exceed 0·0005in per hour. The most important feature of the process, in comparison with electroplating, is the absence of the factor known as "throwing power." In electroplating the operator must be concerned with the relative placement of the part and the anode to obtain a fair degree of uniformity in metal deposition, but it would be impracticable to use anodes of the number and shape necessary to achieve the kind of uniformity provided by a chemical process. In the case of copper and brass, which are non-catalytic to the process, one of two special techniques must be used. With the first of these techniques the surface must first be dipped in a solution of a catalytic metal such as palladium; alternatively, with the second technique, it must be in contact with a catalytic metal such as steel or aluminium while it is immersed, until the plating out process begins.

African Engineering News

(By Our South African Correspondent)

Vierfontein Power Station

The first of the ten turbo-generators at the £13,000,000 power station which is being built at Vierfontein, Orange Free State, was put into operation early in May. These generators, each with a capacity of 30MW, will supply the much-needed power to the Free State goldfields. The other nine generators will be brought into use at intervals and the ultimate capacity of the plant will be 300MW.

The greater part of the output of the Vierfontein colliery, which is less than half a mile away, will be used by the power station. The coal will be transported by conveyor belt from a 12,000-ton staith direct to the boilers, each of which will consume 16 tons of coal an hour and produce 100 tons of steam an hour. The power station has three cooling towers, each 306ft high, the total capacity being 9,000,000 gallons of water per hour.

It is stated that the abundance of low-grade coal available has been taken advantage of by the economic design of this plant, producing power at a cost which, having regard to the increased prices of equipment, will compare favourably with other power stations designed and built by the Electricity Supply Commission.

Uranium Deposits in Rand Mines

More than 500,000 samples of material from the various gold mines in the Union have been assayed for radio-activity by the laboratory unit of the Government's Atomic Energy Board. These assays are part of an investigation financed by the Government into the nature and mode of occurrences of deposits of prescribed materials in the Union of South-West Africa.

In the early stages the investigation showed that uranium occurs in small but significant quantities in nearly all the gold-bearing reefs of the Witwatersrand. The quantity of uranium in the mill heads is in no way reduced by the several stages of processing of gold-bearing ores for the extraction of gold. On account of the fact, therefore, that the major portion of the mining and crushing costs is borne by the main product, gold, uranium becomes a by-product, the extraction of which, in conjunction with the recovery of gold, becomes an economic proposition. As long as the gold mines of the country continue to operate, so long will it be possible to produce uranium oxide as a by-product.

As an example of the recent developments in this activity, Randfontein Estates have just announced that arrangements have been made with the Atomic Energy Board, whereby the company will extend its plant for the treatment of uranium-bearing slimes produced at East Champ D'Or mine. It is expected that the extension of the plant will be completed in the first half of next year.

Goods Yard at Cape Town

When the new goods sheds of the Culemborg goods yard on Cape Town's foreshore are brought into use next year the first instalment of the large-scale plan to improve railway services in Cape Town in particular and the Western Province in general, will virtually have been completed. After the harbour works had been completed, including the Duncan dock and the Sturrock graving dock, the layout of part of the reclaimed area as a modern goods yard was started in 1947. The estimated cost of the goods yard complete with buildings, tracks and platforms is £3,158,000.

The engineering part of the work was characterised by diversity. Land at Paarden Eiland had to be reclaimed and this required the transportation of about 500,000 cubic yards of sand from the new national airport at Bellville. Earthworks for the goods yard itself totalled 873,000 cubic yards. Reinforced concrete bridges to carry seven railway tracks over the Salt River canal had to be provided, while 4·8 miles of main line and 30 track-miles of loops and sidings had to be constructed. Two road bridges are included in the scheme. One is an extension to the existing road bridge and consists of a reinforced concrete bridge, 50ft wide, spanning six tracks. The other bridge will carry the new national road over the new tracks to the harbour. It will span four tracks and the width between parapets will be 113ft. This bridge is at present under construction, and it is anticipated that road traffic will pass over it by about September, 1953.

The main goods shed is 1440ft long by 420ft wide, including cantilever roofs. There are five main roofs, each 75ft span, consisting of steel roof trusses supported on steel columns, and two cantilever roofs, each 22ft 6in. Roofing material consists of corrugated asbestos cement sheeting with roof lights. The shed is divided into two portions by a road which runs approximately through the middle of the shed. The Cape Town end of the shed is to be used for general goods traffic and has six platforms, each served by a rail track on one side and a road on the other. The other portion of the shed is for transhipment working and consists of six platforms, each served by tracks on both sides, and two platforms each served by a track on the one side and a road on the other. The second shed is 880ft long by 75ft wide, of similar construction to the main shed and is served by two rail tracks running down the middle of the shed and roads along the outside. The two goods sheds have a roof area of approximately 14 acres. Half of the transhipment sheds was opened for traffic in June last year.

The wagon repair depot has a repair shed 500ft long by 60ft wide, and offices and stores 280ft long by 40ft wide. The oil reclamation building is 100ft long by 30ft wide of similar construction. Roads and parking areas in the vicinity of the goods sheds were major items. The total extent of this area, all hardened with stone, is approximately 138,500 square yards. This item for roads also includes the hardening and asphalting of approximately 18,300 square yards at the coal sites.

The building group, which has been designed by a firm of Cape Town architects, will consist of the main administrative block, entrance and exit gates, a tarpaulin depot, a police post, a building screening the ends of the goods sheds, a clothing depot and an amenities block. The buildings are grouped round an open concourse for marshalling delivery vehicles, both received and forwarded, and from the eastern boundary of the newly planned Cape Town foreshore.

The basement of the main administrative building is of waterproof construction, as the water table is approximately 5ft below the ground surface. The building is carried on concrete piles. The superstructure is dominated by a tower which rises from the three-storied central block. The tower is a utility one and houses the lift motors and water storage tanks. This block is set back from the main building line and is flanked on each side by a two-storey wing to create a "U" shaped forecourt to the main block.

Pyrochlore Discovery in Northern Rhodesia

It is reported that samples of pyrochlore, composed largely of the combined oxides of columbium and tantalum, have been discovered in the Northern Province of Northern Rhodesia. The proportion of the two oxides is 73·46 per cent, which is almost 10 per cent more than the proportion recorded in any other pyrochlore. It has also the highest columbium content yet recorded in a member of the pyrochlore mineral group. Columbium is one of the metals that, alloyed with steel, resists corrosion at very high temperatures and is used largely at present in jet engines, particularly for exhaust systems. The above mentioned samples are now being analysed by the Mineral Resources Division of the Imperial Institute in London.

Current price is given as £2352 per long ton of concentrate containing a 70 per cent proportion of columbium and tantalum. The world's present suppliers of this mineral are Nigeria, Uganda, Nyasaland, Norway and Germany. The production of pyrochlore is still in its infancy and the demand for it is growing as wider uses are being found for its properties.

Industrial and Labour Notes

Science and Productivity

On Monday last, there was a debate in the House of Commons on science and productivity. It was opened by Mr. R. R. Stokes, who referred to the recent report of the Advisory Council on Scientific Policy (extracts from which were printed on page 78 of our last issue). In the course of his remarks, Mr. Stokes said that industry was left with all too little with which to carry out any development which was desirable, and that the cost of replacements—owing to the considerable rise in prices in recent years—was now so heavy that the margin left with industry was all too little in which effectively to bring about those replacements. Mr. Stokes went on to emphasise the importance of central industrial research, and said also that the important thing in getting production up was to have everybody interested in increasing it. With the engineering industry particularly in mind, Mr. Stokes commented that if only people would realise that by making the task lighter we were not merely pandering to the inordinate desire of man to get the maximum result with the least effort, but that we were trying to make a tremendous contribution to increased production, then he believed that " we would go places." He wanted to see a far greater mechanisation of the manual effort in the workshop, making the job lighter and saving fatigue, for he believed that that would lead to very astonishing results.

The debate was wound up by the Minister of Labour, Sir Walter Monckton, Q.C., who emphasised the importance of the subject of science and productivity. All the matters raised during the debate, he said, had some bearing upon the central theme of all our economic thinking, which was how to increase our exports in an increasingly competitive world market. The difficulties, Sir Walter continued, were not to be found so much in limited supplies of materials, nor to the same extent as they were in delivery dates, nor in general in producing goods of the right quality. The trouble was in producing goods at the right price, and that was where productivity came in. Sir Walter went on to speak of the difficulty of introducing changes in working methods unless human relations were good and there was readiness to entertain such changes. One of the chief obstacles to the rapid introduction of new and more efficient processes to-day lay in the fact that many employers refused to consider the reorganisation of their undertakings because they were afraid of the resistance which reorganisation might arouse amongst those who worked in them. Because of that, Sir Walter commented, they sometimes hesitated to disturb traditional practices which had grown up around old-fashioned ways of doing the job. He was not saying that the old-fashioned ways were wrong or should necessarily be abandoned, but he did say that we should not hesitate to introduce changes when we were satisfied that they were wise and necessary for efficiency.

Wholesale Prices

According to information published in the *Board of Trade Journal*, the wholesale prices of some materials decreased substantially in the first half of this year. The index representing all basic material prices, however, showed a relatively modest decline of just over 4 per cent, compared with a fall of nearly 12 per cent in the first half of last year. The wholesale prices of the many manufactured articles for which official indices are available showed very diverse movements in the first half of this year, but in general these were small. In respect, therefore, of materials purchased by British industries and of materials sold by them, there has been a tendency towards a greater steadiness of price levels.

The Board of Trade says that the fall in the prices of materials used in the mechanical engineering and the electrical machinery industries, which began in August, 1952, was more marked in the first half of this year, when their indices fell by 3·9 and 7·3 per cent, respectively, than in the second half of last year when they declined by only 1·8 and 2·9 per cent, respectively. The fall in the prices of the materials used in these two sectors of industry followed rises of 6·4 and 5·4 per cent, respectively, in the first half of 1952. The downward trend in both indices between December, 1952, and June, 1953, was attributable mainly to the considerable reduction in the prices of non-ferrous metals during this period, which, assisted by falls in the prices of raw rubber and of imported softwood, brought the indices back to the levels of January, 1952, and June, 1951, respectively. It is pointed out that the fall in the electrical machinery materials index was almost twice as great as that in the mechanical engineering index. This, the Board explains, was due not only to the much heavier weight carried in the former index by non-ferrous metals, but also to the far smaller weight carried in that index by iron and steel items, the prices of which, in general, rose by approximately 1·3 per cent during the period surveyed.

The tables included in the Board of Trade's survey show that in June, 1953, the price index numbers of materials used in various sectors of industry (June 30, 1949=100) were as follows: mechanical engineering industries 143·1; electrical machinery industry 150·8; building and civil engineering 130·2.

The Iron and Steel Consumers' Council

The Iron and Steel Consumers' Council, which was set up in accordance with the provisions of the Iron and Steel Act, 1949, has now published its second report. It is explained that the report is not due until September 30th, but as, under the Iron and Steel Act, 1953, the Council ceased to exist on the " appointed day," its second and final report was brought forward and covers the period October 1, 1952, to June 30, 1953.

The report expresses the Council's satisfaction at the general improvement, during the period reviewed, in the iron and steel supply situation. But it expresses concern about the steel plate position and advances the view that " adequate steps are not being taken to ensure that, in future years, supplies will meet the increasing demand." In the opinion of many consumers, the report says, the first need is a mill suitable for rolling plates $\frac{1}{16}$in to $\frac{3}{8}$in thick by 8ft wide, and they think that this should be followed by a heavy mill for plates up to 3in thick and up to 15ft wide.

The report goes on to say that, whilst the British Iron and Steel Federation agrees that the present production of plates is insufficient, it can find no justification for the view held by many consumers that the position may well become progressively worse. On the question of wide plates, the Federation has informed the Council that there are plans making provision for an output of plates over 8ft wide, and that discussions are proceeding with the industries known to be mainly interested to see whether those provisions are likely to be adequate. The Federation is not yet satisfied, the report observes, " that the present plans for expansion in plate production are insufficient." Some consumers are of the opinion that there is need for more capacity for the production of wide plates, as they consider that wider plates are becoming increasingly essential in modern industry, and that it is necessary for them to be freely obtainable down to $\frac{1}{16}$in thick in order to enable consumers to compete with foreign and particularly American industry. On its part, however, the report adds, the Federation doubts whether the demand for wide plates would be big enough to give sufficient loading for a major unit of the kind required. The capital cost of such a unit would be very heavy and the Federation is not convinced that it could be run sufficiently economically to make it preferable for a user to buy these wider plates rather than the narrower plates which are at present used.

About the gap between the supply and demand for plates, the report says that it cannot be measured in precise figures. Various estimates have been made ranging as high as 250,000 tons and 350,000 tons a year. The Consumers' Council feels strongly that the matter should be pursued further, and recommends that the Iron and Steel Board should be asked to examine the problem as soon as it can, including particularly the possibility of increasing rolling capacity in the traditional plate mills, as distinct from strip and universal mills.

Overseas Trade Figures

The Board of Trade's final figures concerning exports and imports in June show that the value of United Kingdom goods exported during the month was £204,000,000. This brought the monthly average in the second quarter of the year to £210,000,000, which was slightly above the average of the first quarter. The Board of Trade points out, moreover, that each month of the second quarter included a public holiday. Taking the first half of this year, the average monthly value of exports was £209,000,000, which was about 3 per cent above the level of the preceding six months and 8 per cent below the monthly average in the first half of 1952. Estimates which have been made indicate that in the first half of this year the volume of exports was about 4 per cent above the level of the second half of 1952.

Between the first and second halves of 1952, the value of United Kingdom exports declined by 10 per cent, largely as a result of import restrictions imposed in some Commonwealth countries, and because of a growing shortage of sterling in some non-sterling markets. The Board of Trade says that a measure of recovery was achieved towards the end of 1952 and, on the whole, was maintained in the first half of 1953. In recent months there has been an improvement in exports to dollar and O.E.E.C. countries and to those sterling countries which are able to admit British goods fairly freely. In the second quarter of this year, exports to the sterling area were not much different from the level of the first quarter, but exports to the non-sterling countries increased by about 3 per cent.

The value of imports in June was £292,000,000 which was a little below the figures for April and May. The monthly average value of imports in the second quarter of this year was, however, 7 per cent above the first quarter average. According to the Board of Trade figures, import prices have declined steadily during the last eighteen months. Provisional estimates show that the volume of imports in the first half of this year was probably about 2 per cent higher than in the first half of 1952.

The Coal Board's Quarterly Statement

This week the National Coal Board has issued a statistical statement showing the costs of production and the proceeds of collieries for the first quarter of this year. It is estimated that, after making provision for interest payable to the Minister of Fuel and Power, the Board had a surplus at the end of the quarter of £541,133. Colliery profits were £5,523,133, profits of ancillary undertakings amounted to £740,000, but there was an estimated loss of £12,000 on opencast coal working. The amount of coal disposable commercially in the quarter was 50,957,172 tons, the proceeds from sales being £162,809,144. The total costs were £157,286,011. The average weekly cash earnings of all workers in the coal mining industry in the quarter were £11 9s. 7d, the average weekly cash earnings of face workers being £13 8s. 5d.

Notes and Memoranda

Rail and Road

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—At a recent meeting of the council of the Institute of Road Transport Engineers, Mr. G. Mackenzie Junner, M.I.Mech.E., was re-elected president for the year 1953–54. Mr. J. H. Vincent and Mr. A. H. Dack were re-elected to their respective offices of honorary secretary and honorary treasurer.

HIGH-SPEED DIESEL ENGINE FOR ROAD VEHICLES.—Arrangements have now been made by Commer Cars, Ltd., whereby the larger models in its "Superpoise" six-cylinder range—5-ton and 8-ton and 10-ton tractor models—can be fitted with the new and more powerful Perkins "R6" diesel engine as an alternative to the high-rated "P6" engine. The "R6" engine develops 108 b.h.p. at 2700 r.p.m.

NORTHERN IRELAND RAILWAYS.—The Northern Ireland Ministry of Commerce has authorised the Ulster Transport Authority to abandon all sections of the former Belfast and County Down Railway that have already been discontinued. The sections referred to are between Ballynahinch Junction and Ballynahinch; Downpatrick and Ardglass; Comber and Newcastle, except that portion which runs from the railway station, Newcastle, to the junction of the main line with the Castlewellan branch line, and between Belfast and Donahgadee, except that portion which runs from the railway station at Queen's Quay, Belfast, to Ballymacarret Junction.

RAILWAY ELECTRIFICATION.—The Minister of Transport was asked in Parliament on Monday last what progress had been made in the past five years in railway electrification. In reply, the Minister said that on British Railways the electrified line from Liverpool Street to Shenfield, with the associated branch from Fenchurch Street to Stratford, was opened to traffic in November, 1949, and the Manchester-Sheffield-Wath scheme was partly completed. Other schemes were in contemplation. During 1948 and 1949, the London Transport Executive electrified and absorbed a total of 16·89 miles of existing surface lines in completion of the extension of the Central Line.

LONDON TRANSPORT INQUIRY.—The Committee of Inquiry into London Transport, the appointment of which was announced recently by the Minister of Transport, invites interested organisations or persons to submit evidence to assist the committee in its task. Those wishing to submit evidence are asked to send it, in writing in the first instance, as soon as possible and in any event not later than October 31st next, to the Secretary of the Committee, Mr. B. E. Bellamy, at the Ministry of Transport, Berkeley Square House, Berkeley Square, London, W.1. The committee's terms of reference are: "To inquire into the conduct of the undertaking carried on by the London Transport Executive (excluding any questions relating to charges) with a view to ascertaining what practical measures can be taken by the British Transport Commission and the Executive in order to secure greater efficiency or economy."

Miscellanea

MR. WALTER YATES.—We note with regret the death of Mr. Walter Yates, M.I.Mech.E., which occurred on July 11th at his home at Egerton Park, Worsley, Manchester. Mr. Yates was chairman and governing director of Matthews and Yates, Ltd., Swinton, Manchester. He was a past-president of the Institution of Heating and Ventilating Engineers.

LIGHT METAL JACKS.—We are informed by Tangyes, Ltd., Birmingham, that the company is employing light alloys in the manufacture of its hydraulic jacks to reduce weight. "Hydralite" jacks up to 50 tons capacity are being produced in Birmetal and Birmal aluminium alloy and it is stated that a jack of 25 tons capacity weighs 53 lb in light alloy compared with 188 lb in steel.

LLANDARCY REFINERY.—We are informed by the Anglo Iranian Oil Company, Ltd., that two new units have been commissioned at the Llandarcy refinery and that two more are expected to begin operations by the end of the summer. The recently commissioned plants are a furfural unit and a gas oil heating unit and those about to be commissioned are a propane de-asphalting unit and an M.E.K. dewaxing unit.

OIL EXPLORATION.—The D'Arcy Exploration Company, the prospecting subsidiary of the Anglo Iranian Oil Company, Ltd., has acquired a concession over the Continental shelf area subject to the ruler of Abu Dhabi, the term of the concession being sixty-five years and the area over 12,000 square miles. The company, in association with the Compagnie Francaise des Petroles, has also obtained a concession over the continental shelf area subject to the ruler of Dubai, the area being 1300 square miles and the duration sixty years.

TRADE WITH CANADA.—The Canadian Association of Manufacturers and Agencies has prepared a directory giving information about British products which are available in Canada, and their channels of distribution in that country. This directory, which is entitled *Cabma Register* 1953, contains the names of over 4500 British manufacturers and 2750 Canadian distributors, and gives some particulars of 3750 or so British made articles. It also includes a glossary showing the French-Canadian terms for the products listed in the buyers' guide section. The directory is published for the Canadian Association of Manufacturers and Agencies by Associated Iliffe Press, Ltd., Dorset House, Stamford Street, London, S.E.1.

ORE CRUSHERS IN NORTHERN ONTARIO.—Five new crushers have recently been installed by the International Nickel Company of Canada, Ltd., at its Creighton and Frood-Stobie Mines in Northern Ontario, as part of its underground mining expansion programme. Each of these machines weighs 165 tons and crushes about 450 tons of ore an hour, reducing it to 8in chunks. The stations housing the underground crushers in operation at the mines are located from 500ft to 5000ft below the surface. Each station is lined with reinforced concrete and the back is supported by heavy steel beams.

B.I.C.E.R.A.—The British Internal Combustion Engine Research Association states that at the annual general meeting of the Association Viscount Falmouth was re-elected president and that Air Commodore F. R. Banks, C.B., O.B.E., the Principal Director of Engine Research and Development, Ministry of Supply, Dr. S. F. Dorey, C.B.E., chief engineer surveyor, Lloyd's Register of Shipping, and Lieut.-General Sir Frederick G. Wrisberg, K.B.E., C.B., were re-elected vice-presidents. Also elected as vice-presidents were Vice-Admiral (E) F. T. Mason, C.B., Engineer-in-Chief of the Fleet, Major-General H. R. B. Foote, V.C., C.B., D.S.O., Director-General, Fighting Vehicles Division, Ministry of Supply, and Sir Harold Roxbee Cox, Ph.D., Chief Scientist, Ministry of Fuel and Power.

IRON AND STEEL STATISTICS.—The British Iron and Steel Federation has published Part II of its *Statistical Year Book for* 1951, which contains detailed figures from every important iron and steel producing country overseas. Three summary tables at the beginning of the volume indicate the changes in the world's iron and steel industry over a long period. Another table shows the changes since 1939 in hard coal production. Entirely new sections give information concerning Algeria, Ceylon, Egypt, Pakistan, Rumania and Yugoslavia. The price of the volume is 15s. The Federation has also published Part I of its *Statistical Year Book for* 1952, which relates to the United Kingdom. Its many tables cover not only all aspects of iron and steel production, but also give particulars of exports and imports, employment in the industry, prices, deliveries, stocks, consumption and scrap. This volume costs 7s. 6d. Both volumes are obtainable at Steel House, Tothill Street, London, S.W.1.

COOPERS HILL WAR MEMORIAL PRIZE.—The Institution of Electrical Engineers states that the triennial award of the Coopers Hill War Memorial Prize and Medal has been made to Mr. G. Lyon, M.Sc. (Eng.), A.M.I.E.E., for his paper on "Some Experiences with a British A.C. Network Analyser." The Coopers Hill War Memorial Prize, which was founded by the members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the first world war, is awarded annually by the Institution of Civil Engineers, and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. The prize, which consists of a bronze medal, a certificate and about £20 in money, is awarded for the best paper on a professional subject published by the Institution during the period of the award, but only authors who are corporate members under thirty-five years of age are eligible.

THE VISCOSITY AND DENSITY OF LUBRICATING FLUIDS.—The American Society of Mechanical Engineers says that recent experimental work has resulted in comprehensive data on the viscosity and density of more than forty lubricating fluids at temperatures from 32 deg. to 425 deg. Fah. and at pressures up to 150,000 lb per square inch. These new data are presented in two volumes entitled *Pressure Viscosity Report*, which has been issued by the Society's Research Committee on Lubrication. The research leading to this report was a co-operative effort, twenty-seven industrial concerns providing financial support for the project. An advisory board composed of experts from universities, Government laboratories, and the petroleum, synthetic lubricant and equipment building industries contributed their services to ensure representative selection of test fluids and to advise on the conduct of the experimental work. Petroleum and Government laboratories made physical and chemical inspection tests on the fluids to ensure that all fluids tested were properly identified. The pressure-temperature-viscosity-density measurements were carried out at Harvard University under the direction of Professor R. V. Kleinschmidt.

THE END OF COPPER CONTROL.—The Minister of Supply has made the Copper, Lead and Zinc Distribution (Revocation) Order, 1953, which will become effective on August 5th. When the London Metal Exchange resumes dealings in copper next month, licences will no longer be required for the purchase of any form of copper. About copper imports, the Board of Trade has announced arrangements to facilitate the private purchase of unwrought, refined and blister copper in the form of anodes, bars, billets, cakes, cathodes, ingots, ingot-bars, slabs and wirebars by consumers and other dealers. Members of the London Metal Exchange who participate in the Bank of England exchange control scheme will be granted open individual licences valid for importing from any source. Applications for open individual licences to import unwrought copper will also be considered from consumers and producers' agents who wish regularly to import substantial quantities other than through the medium of the London Metal Exchange; such applications should state the quantities expected to be imported during the ensuing twelve-monthly period and the sources of supply. All applications should be made on Form ILB/A and addressed to the Import Licensing Branch, Board of Trade, 43, Marsham Street, London, S.W.1.

AIR POLLUTION COMMITTEE.—On Tuesday last, Mr. Marples, Parliamentary Secretary to the Ministry of Housing and Local Government, stated that a committee had been set up to inquire into the problem of air pollution. Sir Hugh Beaver, M.I.C.E., had agreed to serve as chairman of the committee, the task of which would be to examine the nature, causes and effects of air pollution, consider what further preventive measures were practicable, consider the efficacy of existing preventive measures, and make recommendations. Mr. Marples said that this committee would begin its work forthwith, but he could not predict when its report would be made.

Personal and Business

MR. J. A. THOMSON has been appointed a director of Macrome, Ltd., Wolverhampton.

THE DUNLOP RUBBER COMPANY, Ltd., announces the retirement of Mr. C. L. Guest, its chief industrial engineer.

MR. D. MAXWELL BUIST, M.I.E.E., export director of BEAMA, has been re-elected chairman of the council of the Institute of Export.

V. L. FARTHING AND CO., Ltd., has changed its address to 327–329, Tower Building, Water Street, Liverpool, 3 (telephone, Central 9626).

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., states that the Hon. A. C. Geddes has resigned from the board in order to be free to develop his personal business interests.

BRITISH INSULATED CALLENDER'S CABLES states that its Exeter branch office will be moved on August 1st to 40, Whipton Village Road, Whipton, Exeter (telephone, Exeter 67308).

MR. A. O. BLÜTH has been appointed to the board of Vickers-Armstrongs, Ltd. He is a director of Erlangers, Ltd., and vice-chairman and managing director of the Jack Olding organisation.

AYLESBURY TURNED PARTS (TRUE SCREWS), Ltd., Britannia Street, Aylesbury, Bucks, announces the appointment of Mr. G. O. Cordwell as sales representative for the Greater London area.

THE LOCKHEED HYDRAULIC BRAKE COMPANY, Ltd., states that Mr. Ivan M. Waller, B.A., has joined the organisation to develop the Lockheed-Avery flexible pipe and self-sealing couplings division.

CHAMBERLAIN INDUSTRIES, LTD. (PLANT DIVISION), Staffa Road, Leyton, London, E.10, has been appointed London and Home Counties agent for the Dixon rollers manufactured by Dixon Hawkesworth, Ltd.

MR. J. Y. DANKS, M.I.C.E., is relinquishing his position as civil engineer in the London division of the British Electricity Authority to become an executive director of Sir William Arrol and Co., Ltd., Glasgow.

SIR GILBERT DAVIS, Bart., and Mr. E. W. Yetton have been appointed to the board of Eastwoods, Ltd. Mr H. E. Severn has been appointed secretary and Mr. Kenneth Miller assistant general manager of the company.

STRUCTURAL AND MECHANICAL DEVELOPMENT ENGINEERS, Ltd., 2, Buckingham Avenue, Slough, states that in future it will be known as S.M.D. Engineers, Ltd. The telegraphic address has been changed to "Alframe, Slough."

LONDON TRANSPORT announces the retirement, which will take effect on August 1st, of Mr. C. S. Boughton, principal assistant architect (road transport). Mr. Boughton has completed forty-one years' service with London Transport and its predecessors.

THE OWEN ORGANISATION OF GREAT BRITAIN has established a company in Canada to handle the sales of some of the main Owen firms. This company is entitled Rubery Owen Canada, Ltd. Mr. B. S. Male is the manager, the offices being at 1470, The Queensway, Postal Station N, Toronto, 14.

ALLEY TRAILERS, Ltd., Burnham Market, Norfolk, has transferred its headquarters to Maldon, Essex, in order to be in direct association with E. H. Bentall and Co., Ltd., which manufactures its products. Sale Tilney (Agricultural and Industrial), Ltd., Wokingham, Berks, has been appointed world distributor of Alley products. A new company, known as Alley Consultants, Ltd., has been formed at Burnham Market to deal with the design and development of trailers and agricultural machinery. Mr. Eric Alley is the managing director of the new company.

Contracts

VICKERS-ARMSTRONGS, Ltd., has announced that it has received an order for three "Viscount" propeller turbine airliners from Iraqui Airways.

THE GENERAL ELECTRIC COMPANY, Ltd., announces that its Fraser and Chalmers Engineering Works, Erith, Kent, has received through the British General Electric Company (Pty.), Ltd., a contract to provide a coal preparation plant for the Corrimal Coal and Coke Pty., Ltd., of Sydney, N.S.W. This plant is to have a capacity of 200 tons per hour of coking coal, and the equipment includes one 10ft diameter Chance cone with ancillary screening and loading equipment, which will comprise Sherwen electromagnetic screens and Fraser and Chalmers shaker screens. In addition, a water clarification plant is to be supplied, and the whole will be installed at Corrimal Colliery, near Port Kembla, N.S.W., some 40 miles south of Sydney.

British Patent Specifications

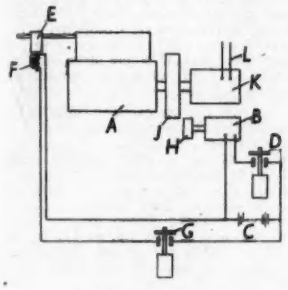
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

693,304. November 16, 1950.—STARTING AND STOPPING INTERNAL COMBUSTION ENGINES, Hampson Industries, Ltd., Arthur Street, West Bromwich. (*Inventor: Thomas Hampson Silk.*)

The invention provides a simple means for starting and stopping a diesel or other internal combustion engine used for driving an electric generator. In the drawing an engine *A* has associated with it an electric starting motor *B* supplied with current from a battery *C*; the motor is stopped or started by a manual switch *D* having combined with it a time-lag device adapted to prevent reopening of the switch by a spring until after the lapse of a predetermined time, which is sufficiently long to allow the motor



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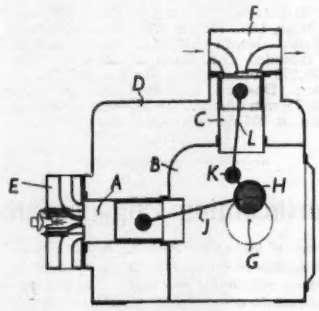
to start the engine under normal conditions. For stopping the engine any convenient means is employed such as a normally open and spring-loaded valve *E* to interrupt the fuel supply to the engine. This valve can be closed by an electro-magnet *F* energised by the closure of another similar manual switch *G*. The starting motor is of the kind which is provided with a pinion *H* moved axially and automatically into and out of engagement with gear teeth on the flywheel *J* of the engine. Any other appropriate starting motor may be used. The generator *K* may be alternating or direct current and it can supply a charging current to the battery as well as to a load circuit.—*June* 24, 1953.

693,297. September 4, 1950.—A MOTOR-COMPRESSOR UNIT, Hans List, 126, Heinrichstrasse, Graz, Austria.

Referring to the drawing, the engine illustrated is a single cylinder diesel engine, the cylinder *A* of which is arranged horizontally and attached to a crank casing *B*, within which the engine crankshaft is arranged. The compressor cylinder *C* is arranged vertically above the crank casing and is attached to it so that the axes of the engine cylinder and the compressor cylinder are at right angles. The engine cylinder and compressor cylinder are housed within



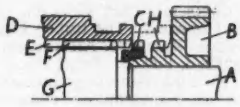
No. 693,297

a common water cooling space *D*. A compact construction of the engine and compressor unit is thus obtained and it is easy to keep the unit clean owing to the flat and smooth surfaces of the casing. The cylinder head of the engine cylinder *A* is provided with a water cooling space *E* which is connected to the common water cooling space *D* of the engine and compressor cylinders, the compressor cylinder head also having a water cooling space *F*. Cooling is preferably by circulating the cooling water from the water cooling space *F* of the compressor cylinder head passing to a radiator and returning from it to the water cooling space *D* at its deepest point. The crankshaft *G* is provided with a single crank *H* which is engaged by the connecting rod *J* of the engine, the compressor being preferably driven by an auxiliary connecting rod linked to the connecting rod *J*, which is provided with a journal *K* to which the auxiliary connecting rod *L* of the compressor is connected. The reciprocating masses of the engine, inclusive of the engine piston, and the reciprocating masses of the compressor, inclusive of the compressor piston, are approximately equal so that a reliable balancing of the masses can be obtained.—*June* 24, 1953.

POWER TRANSMISSION

693,324. May 8, 1951.—CHANGE SPEED GEARS, Fiat Societa per Azioni, 300 Corso IV Novembre, Turin, Italy.

The invention relates to change speed gearing, more particularly to the gears provided with a synchroniser rim. Referring to the drawing, *A* is the change speed gear shaft, having arranged on it a toothed wheel *B*, a synchronising cone *C* and an operating sleeve *D* with teeth *E* which are constantly engaged in the spaces between the teeth *F* on a pinion *G* fast with the shaft *A*. The sleeve *D* is axially displaceable to the shaft, in order to operate the synchronising cone *C* and, thereafter, to become directly coupled with a toothed rim *H* fast with the



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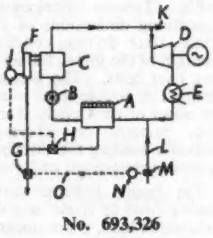
toothed wheel *B*. The flanks of each tooth on the sleeve have notches formed in them, of a length such that, when the sleeve *D* reaches (under the action of the change speed gear lever) the end of its stroke and takes the position shown by broken lines in the drawing, each of the notches engages the whole length of a tooth *H*, the tooth being brought to this position by the rotation of the member, performing just then the function of a driving member, so that any accidental uncoupling of the gear is made impossible, as long as the resisting couple acting on the driven number is operative. On operation of the engine clutch, the resisting torque ceases and the sleeve *D* may be released from the teeth *H* with little effort by the driver on the operating lever.—*June* 24, 1953.

STEAM GENERATORS

693,326. May 22, 1951.—CONTROL OF SALINITY IN STEAM GENERATING PLANTS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

The invention relates to the control of salinity in steam generating plants of the kind in which water enriched in salts is continually blown down from the steam generator, and at least some of the condensate and a make-up amount of water constitute the feed water. In the steam generating plant shown in the drawing the feed water is drawn from a feed water reservoir *A* by a feed pump *B* and is forced into a steam generator *C*. The high pressure steam generated flows to and expands in a turbine *D* and then passes to a condenser *E*. The condensate returns to the feed water reservoir *A*. The steam-water mixture flows from the vaporiser of the steam generator *C* into a water separator *F* associated with the steam generator, and in it most of the water component of the mixture is separated out by centrifugal action. The steam, from which the water has been separated, flows from the water separator *F* to the superheater of the steam generator, whereas the separated water, enriched with salts, flows out of the water separator towards a blowing down valve *G*. Most of this blown down water is returned to the circuit of the working medium of the steam generating plant through a valve *H* which is regulated by a water gauge *J* in dependence on the water level in the separator, in such a way as to maintain the water level therein practically constant. To replace the water blown down through the valve *G* and to make up the unavoidable losses in the circuit of the working medium of the steam generating plant, losses which are indicated by the arrow *K*, the necessary amount of make-up water is admitted through a pipe *L*. In the salinity control system shown in the drawing the regulation of the amount of water blown down depends on the amount of make-up water, so that this system is suitable only where there is an approximately constant concentration of salts in the make-up water. In this case the



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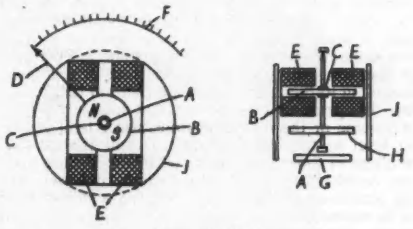
make-up amount is measured by means of a flow meter *M* incorporated in the pipe *L*. An impulse transmitter *N* is associated with the flow meter and converts the reading of the flow meter into a controlling impulse which is transmitted through an impulse pipe *O* to the blowing down valve *G*. The system is arranged so that the amount of water blown down increases proportionally as the flow of make-up water increases, and vice versa. The amount of water blown down, having regard to the approximately constant concentration of salts in the make-up water, is therefore adjusted to depend on the rate at which salts are supplied to the steam generator in the make-up water flowing in through the pipe *L*. Two other drawings and descriptions of modified arrangements are also included in the specification.—*June* 24, 1953.

ELECTRICAL ENGINEERING

693,627. March 3, 1950.—SINTERED MAGNETIC ELEMENTS FOR ROTARY-MAGNET MEASURING INSTRUMENTS, Siemens and Halske Aktiengesellschaft, Siemensstadt, Berlin, and Wittelsbacherplatz 4, Munich, 2, Germany.

The object of the invention is to provide a high-grade rotary magnet instrument for measuring currents, voltages and values related to currents and voltages. It provides a sintered magnetic element for a rotary magnet instrument having a field produced by a coil subjected to the current or the voltage to be measured. The magnetic element comprises a circular disc magnetised in one diametrical direction and of a magnetic material known under the trade name of "Oerstit 400," comprising aluminium, nickel, cobalt, copper and iron in the following proportions: Aluminium, 8 per cent; nickel, 15 per cent; cobalt, 23 per cent; copper, 4 per cent; iron, 50 per cent. Referring to the upper drawing, there is shown mounted on a spindle *A*, which carries the pointer, a disc-shaped rotary magnet *B* formed of "Oerstit 400." A soft iron core *C* is secured in the centre of



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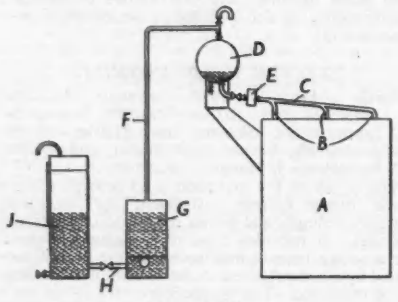
the disc by sintering, for fastening the disc to the spindle. The magnetic field of the disc-shaped magnet *B* extends in the direction of a needle *D* and comprises two pronounced poles approximately at the points *N* and *S*. Coils *E* mounted adjacent the disc-shaped rotary magnet are arranged to be connected to the source of current, voltage or current and voltage which is to be measured so that the rotary magnet is deflected. The zero position of the rotary magnet and, consequently, the needle in relation to a scale *F*, is adjusted by means of a control magnet *G* (see right-hand view), which is disposed parallel to the rotary magnet *B*. In the astatic measuring mechanism illustrated in the right-hand view, the spindle *A*, having the disc-shaped rotary magnet *B* mounted on it by means of a soft iron core *C*, is shown with magnetic coils *E* disposed symmetrically. In order to eliminate any influence arising from foreign magnetic fields, there is mounted on the spindle a magnet *H*, which is arranged in such a spaced relationship from the assembly embodying the coil *E* and the rotary magnet *B*, that the currents flowing through the coil do not act on it or, if so, to only a negligible extent. It is preferable for the rotary magnet *H* to be inverse in magnetic relationship to that of the rotary magnet *B*. Furthermore, it is preferable to arrange for the external dimensions and strength of the two rotary magnets to be substantially equal and made of the same material. A control magnet *G* is arranged for the purpose of setting the needle *D* at its zero position and is formed of the same material as *B*. It is adjustable in order to enable corrections to be effected to the zero setting. The instrument may also be provided with a screening cover *J* designed to screen off extraneous fields.—*July* 1, 1953.

693,448. October 10, 1950.—ELECTRIC POWER TRANSFORMERS, The British Electric Transformer Company, Ltd., Hayes, Middlesex (*Inventors: Leslie Smith and Frederick Kingsley*).

This invention relates to electric power transformers of the oil-insulated type, in which an inert gas layer is maintained above the oil to prevent access of air. It has particular application to comparatively large transformers, say, of 5000kVA and above. A transformer coil and core assembly is enclosed in a tank *A* and connected to lead-through terminal insulators of any conventional form. The tank is oil tight and

from its top a number of pipes *B* lead to an inclined pipe *C* extending to the bottom of an auxiliary tank *D*. In the pipe *C* immediately below the auxiliary tank *D* a Buchholz protector *E* is fitted, and the arrangement of the top of the tank *A* and piping is such as to pass any gas evolved in the oil in the tank due to faulty operation, up the pipes *B* and *C* to actuate the protector, while the pipes are of such small bore that no convection currents arise. The top of the auxiliary tank *D* is connected by a gas-tight joint to a pipe *F* leading to the top of a cylindrical vessel *G*, and the bottom of this vessel is connected by a pipe *H* to a similar cylindrical vessel *J* whose top is vented to atmosphere. The transformer tank *A*



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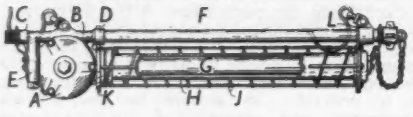
is filled with oil so that such oil extends in a continuous body through the pipes to the auxiliary tank and just enters the auxiliary tank *D* when the oil is cold, and oil is also placed in the lower parts of the two cylindrical vessels *G* and *J*, so that these vessels with their connecting pipe *H* form an oil-filled U-tube. The space between the oil level of the auxiliary tank *D* and the oil level in the vessel *G* connected thereto is filled with nitrogen. The auxiliary tank *D* and the vessels *G* and *J* are each of capacity at least equal to the volume increase of the oil in the transformer tank *A* when heated to working temperature. This minimum volume may be taken as some 7·5 per cent of the total oil volume in the transformer tank, according to the operating temperature to be allowed for. In operation it will be seen that upon any change of volume of the oil in the transformer tank *A*, the oil level in the auxiliary tank *D* will rise or fall, resulting in movement of the oil in the U-tube from one vessel to the other. At no time, however, will the heated oil in the transformer and auxiliary tank be in contact with air, while the oil in the tube which in one vessel thereof is in contact with air, is not heated and has little if any tendency to interact with atmospheric oxygen and form sludge or acid substances.—*July* 1, 1953.

MINING ENGINEERING

690,138. January 16, 1951.—ELECTRIC LIGHTING APPARATUS FOR USE IN COAL MINES, Compagnie Auxiliaire des Mines, 42, Rue du Polygone, Douai (Nord), France.

The invention has for its object a safety lighting apparatus, particularly adapted for use in gaseous coal mines. It comprises a turbo-alternator connected to a compressed air line, supplying a tubular fluorescent lamp. The apparatus comprises a holder consisting of a casing *A* having the general appearance of a flat disc, containing a turbo-alternator which has the same axis as the casing, the turbo-alternator being formed of a turbine and an alternator. A rectilinear pipe *B* with axis tangential to the casing and perpendicular to the alternator axis is ended by two couplings *C* and *D* by means of the first of



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which the apparatus is tapped to the line supplying air or other fluid under pressure. This pipe is connected to the turbo-alternator through an adjustable relief valve *E*, carried laterally by casing *A*. A rigid tubular holder *F* is open at both its ends and is connected by one of them to the coupling *D*. The other end of this tube is arranged to be either connected to the corresponding coupling of another similar electric apparatus, or else to be plugged. A fluorescent tube *G*, protected by either a transparent or a translucent tube *H*, and a cage *J*, both tubes being made air-tight and held, longitudinally, between a first flange *K* fixed to casing *A*, and a second flange *L*, sliding on the tube holder *F* and connected to *K* through the medium of the protecting cage *J*, serving as a staybolt device. A safety electric cut-out device and hanging hooks are provided. Full details of the turbo-alternator and the fittings are given in the specification.—*April* 15, 1953.

Technical Reports

Flameproof Electrical Apparatus: Flanged Joints, One Half-inch in Radial Breadth, in Mixtures of Ethylene and Air (Ref. G/T276). By H. Robinson, J. T. W. Roper and H. L. Williams. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 7s. 6d., postage 3d.—For explosive mixtures of ethylene and air, ignited in an 8 litre bronze sphere having horizontal equatorial flanges one half-inch in radial breadth, the most incendive mixture contains 6·5 per cent of ethylene by volume. The most readily ignitable external mixture contains 6·2 per cent ethylene. The maximum experimental safe gap (M.E.S.G.) associated with this combination of mixtures, on a criterion of $n=20$, $k=0·001$in, is 0·021in; and the statistical maximum safe gap (S.M.S.G. (R)) calculated by the improved method recently adopted, is 0·014in. The effect of reducing the flange breadth from 1in to one half-inch is to reduce the M.E.S.G. from 0·028in (Ref. G/T142) to 0·021in, i.e. by 25 per cent; and to reduce the S.M.S.G. (R) from 0·023in to 0·014in, i.e. by 39 per cent. The tests were made at Buxton in co-operation with the S.M.R. Establishment of the Ministry of Fuel and Power.

Breaking Capacity Tests of 440V, 150A and 75A Three Phase Contactors (Ref. G/T270). By H. W. Baxter and B. Hopwood. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 15s., postage 5d.—This report gives the results of preliminary breaking capacity tests on representative commercial contactors. The breaking capacity clause in B.S. 775–1938 specifies that a.c. contactors for direct-on starters shall make and break a circuit adjusted to give six times their full-load current at a power factor of 0·4 to 0·5 lagging. It is now known that this is not fully representative of practical conditions, since the current may be larger and the power factor may be smaller, especially in the case of a stalled motor. Accordingly the contactors were tested at currents up to eight times their full-load currents and at a power factor of 0·2 to 0·3, which is thought to be more representative of present-day conditions. Since it was also desired to obtain guidance in planning further work of a more fundamental nature, the models chosen were of different designs.

The Behaviour of Aluminium Alloy Riveted Joints. By Professor A. J. Francis, M.Sc., Ph.D. Research Report No. 15, The Aluminium Development Association, 33, Grosvenor Street, London, W.1. Price 7s. 6d.—This report describes the theoretical and experimental investigations into the behaviour of double-shear joints under axially or eccentrically applied static loads in and beyond the elastic range. Examples are given of the elastic and inelastic behaviour of axially loaded joints, together with a note upon their elongation and ductility requirements. There is a general analysis of eccentrically loaded joints, including as an illustration the treatment of joints having four rivets in line and nine rivets. For axially loaded joints theoretical assumptions are verified before discussing experiments on small joints, of which details are given. Load/deformation curves for mild steel and aluminium alloy rivets and for plate sections are included together with partitions of load and load/tilt curves for various specimens. Very long joints are next considered and both the theoretical and experimental results are graphically presented, including curves of loads, partitions of load, elongation and deformation of rivets. Tabular statements set forth information concerning dimensions of joints, properties of materials, rivet driving conditions, strength of plate, strength of the joints, failing loads of plate specimens, and rivet tests. The factors affecting the shearing strength of double-shear joints are examined and also the effect of rivet pitch, diameter/thickness ratio and rivet patterns on efficiency. For joints under eccentric loading the distribution of load among the rivets is investigated and graphically recorded.

The results indicate that the partition of load among rows of rivets in a double-shear joint, under axial static load, is not uniform and that in the elastic range the alloys used have practically no effect on load partition. Rivet alloys, it is shown, must possess ductility since this quality has a bearing on the shearing strength of the joint. The effect of the number of rows of rivets and the pitch is noted and 3·5 diameters to 4·0 diameters is given as the most economic and efficient pitch for cold-driven rivets, while the optimum value of 1·5 is given for the diameter/thickness ratio in double shear. From the results it is advised that joints under static axial load should be designed on conditions at failure and not on elastic conditions or proof load. No fundamental difference was found between joints under compression or tension. For eccentrically loaded joints the distribution of load among rivets is less favourable than assumed in conventional design in the elastic range, but beyond this the shearing strength exceeds the conventional value. It is noted that there is no appreciable scale effect in the behaviour of aluminium alloy joints so that smaller joints could be used for further experimental work.

Launches and Trial Trips

ROYALGATE, coaster; built by the Goole Shipbuilding and Repairing Company, Ltd., for the Hullgates Shipping Company, Ltd.; length 175ft, breadth 27ft 6in, depth 11ft 6in, 700 tons deadweight; British Polar diesel engine, 545 b.h.p. at 300 r.p.m. Launch, June 30th.

IREX, oil tanker; built by Harland and Wolff, Ltd., Belfast, for Skibsaktieselskapet Fjeld; length between perpendiculars 460ft, breadth moulded 59ft, depth moulded 34ft 10in, deadweight 12,000 tons on 27ft 6in draught; twenty-four cargo oil tanks, steam deck machinery, one 50kW diesel-driven generator; Harland-B. and W. single-acting, four-stroke diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 115 r.p.m., two single-ended multitubular boilers. Trial July 8th.

EDMUND GARDNER, pilot vessel; built by Philip and Son, Ltd., Dartmouth, for the Mersey Docks and Harbour Board; length between perpendiculars 165ft, breadth 31ft 6in, depth moulded 14ft 6in, accommodation for a crew of twenty-three and thirty-two pilots; machinery by General Electric Company, Ltd., two 640 b.h.p. National diesel engines, each driving 375kW and 80kW generators, and a single armature propulsion motor of 920 s.h.p. at 300 r.p.m., service speed 12·5 knots. Launch, July 9th.

DISPATCHER, bauxite ore carrier; built by the Burntisland Shipbuilding Company, Ltd., for the Pan-Ore Steamship Company, Inc., U.S.A.; length between perpendiculars 425ft, breadth moulded 60ft, depth moulded 29ft 6in, deadweight 8000 tons, loaded draught 20ft 6in, speed 12·5 knots, two holds, MacGregor steel hatch covers, electric deck machinery, two 250kW geared turbo-generators; David Rowan double reduction geared turbines, 3300 s.h.p. at 112 r.p.m. at propeller, steam at 400 lb per square inch and 725 deg. Fah., two Babcock and Wilcox water-tube boilers. Launch July 9th.

EUMAEUS, cargo ship; built by the Caledon Shipbuilding and Engineering Company, Ltd., for Alfred Holt and Co.; length between perpendiculars 452ft 9in, breadth moulded 62ft, depth moulded 35ft 3in, gross tonnage 7700; Harland and Wolff single-acting, two-stroke, opposed-piston diesel engine, seven cylinders, 7600 b.h.p., three 220kW diesel generators. Launch July 10th.

WILHELM JEBSEN, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for A/R Calorie (Paul Jebsen), Bergen; length between perpendiculars 530ft, breadth moulded 73ft, depth moulded 38ft 10in, deadweight 18,000 tons, summer draught 31ft, service speed 14·25 knots; two 200kW diesel generators, one 90kW steam-driven generator, two Scotch boilers; Swan, Hunter-Doxford opposed-piston oil engine, six cylinders, 725mm diameter by 2250mm combined stroke, 7500 b.h.p. at 115 r.p.m. Launch July 10th.

JEAN LABORDE, passenger cargo liner; built by the Forges et Chantiers de la Gironde for Des Messageries Maritimes; length between perpendiculars 459ft 4in, breadth 63ft 4in, depth to upper deck 38ft 5in, draught 24ft 3in, displacement 13,700 tons, deadweight 6100 tons, service speed 17 knots; two steel decks, nine watertight bulkheads, six holds, MacGregor steel hatch covers; 88 first, 112 tourist and 292 third-class passengers; two Creusot-B. and W. diesel engines, each of ten cylinders, 620mm diameter by 1150mm stroke, 5150 b.h.p.; two La Mont exhaust gas boilers, four 480kW diesel generators. Trial July.

PIERRE LOTI, passenger cargo line sister ship to "Jean Laborde," built by the Navy Yard, Brest, for Des Messageries Maritimes. Trial July.

SHEAF ROYAL, oil tanker; built by Joseph L. Thompson and Sons, Ltd., for the Sheaf Steam Shipping Company, Ltd.; length between perpendiculars 516ft, breadth moulded 73ft, depth moulded 41ft 1in, deadweight 18,275 tons on 30ft 6in draught, service speed 15 knots; Doxford opposed-piston oil engine, six cylinders, 750mm diameter by 2500mm combined stroke, 7750 b.h.p. at 103 r.p.m. Launch July 11th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASLIB.

Fri. to Mon., Sept. 11th to 14th.—The University, Nottingham, 28th Annual Conference.

ENGINEERS GUILD

Thurs., Sept 24th.—METROPOLITAN BRANCH: Caxton Hall, Caxton Street, Westminster, S.W.1, Annual General Meeting, 6 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Aug. 18th.—Visit by a Party of Members to the Works of Scammell Lorries, Ltd., Watford, Herts, 10.45 a.m.